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ESTERLINE ANGUS
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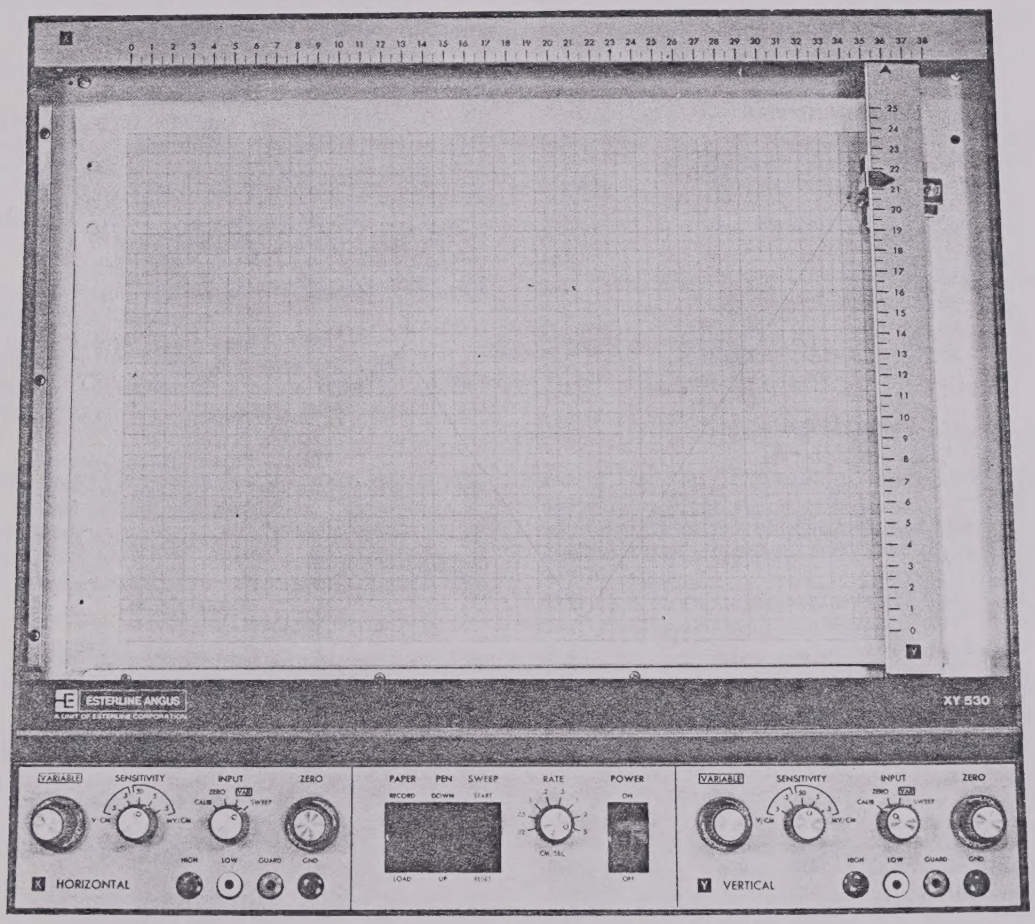
INSTRUCTION MANUAL

FOR
MODEL XY530
RECORDER

SERIAL NUMBER ----------



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NOTE:

FOR A COMPLETE TECHNICAL DESCRIPTION OF YOUR SPECIFIC INSTRUMENT, SEE THE DATA SHEET WHICH IS SUPPLIED WITH THIS MANUAL. SPECIAL DRAWINGS AND SUPPLEMENTARY INSTRUCTIONS THAT MAY BE REQUIRED FOR YOUR RECORDER WILL BE LISTED ON THE DATA SHEET AND WILL ACCOMPANY THIS MANUAL.

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SECTION 1
INTRODUCTION

1-1. PURPOSE

This manual describes installation, operation, and maintenance procedures for the Model 530 X-Y recorders (Figure 6-1). An illustrated parts breakdown and schematic diagram are also included in Section 6. For best performance from the Model 530, acquaint yourself with its features and operating principles before placing the instrument into operation.

1-2. DESCRIPTION

The Model 530 Series X-Y Recorders are precision, general purpose instruments designed to plot Cartesian coordinate graphs, using a horizontal (X-axis) and a vertical (Y-axis). Using these recorders, the relationship between two analog functions represented by dc or low frequency ac voltages may be graphed. On Models 530T and 530TM, an internal precision time base enables any function to be plotted in relationship to time.

The different model configurations available are identified by a model number suffix. For example: Model 530TMRXY. Table 1-1 defines the suffix code.

The Model 530 series recorders are available in either inches or metric calibration. Recorders with metric calibration are identified by the letter M in the model number code. Metric equivalents to all values in inches follow in parentheses throughout this manual.

Table 1-1. Model 530 Series X-Y Recorder Configurations

Model No. Suffix	Description
None	Basic recorder with inches calibration
T	Internal time base circuit
M	Metric calibration
C	Computer reference
RX	Retransmitting potentiometer, X-axis only
RY	Retransmitting potentiometer, Y-axis only
RXY	Retransmitting potentiometers, both axes

A. ACCESSORIES

Each recorder is supplied with the following items (refer to Section 6 for part numbers):

1. One box (100 sheets) of graph paper, 11 by 17 in. or 28 by 42 cm.
2. One six pack of disposable inking-pen cartridges.
3. One set of Allen wrenches.
4. Remote mating connector.
5. Dust cover.
6. One instruction manual.
7. Rack mounting kit (upon order only).

B. OPTIONS

1. Computer Reference Capability

When operating with a computer, the required reference voltages for each axis may be obtained from the computer through the remote connector. Circuit card switches provide selection of either internal or external reference. Refer to Figure 6-18 for the schematic diagram; and paragraph 2-4, C, 4 for hookup instructions.

2. Retransmitting Potentiometers

Retransmitting potentiometers (See parts breakdown) are available for either or both axes. They provide a means of electronically sensing the position of either axis for use in associated equipment. The potentiometers are 5000 ohms and 0.1 percent linearity. An external voltage source and interface wiring are required to use retransmitting potentiometers. If desired, blank pins on the remote connector may be used. For field installation, follow instructions in paragraph 5-3, D, 4.

3. Recorder Service Stand

A service stand (See parts breakdown) is available for convenient holding of the recorder. The service stand supports the recorder in a vertical position for easy removal of the bottom cover and access to the circuit card.

1-3. SPECIFICATIONS

A. INPUT CHARACTERISTICS

1.	Five calibrated ranges with VARIABLE control for continuous adjustment between ranges:	1 mV, 10 mV, 100 mV, 1 V, or 10 V/in. (0.5 mV, 5 mV, 50 mV, 0.5 V, or 5 V/cm).
2.	Maximum Input Voltage:	10 Vdc or peak ac, 1 mV/in. (0.5 mV/cm) or 10 mV/in. (5 mV/cm). 500 Vdc or peak ac, 100 mV/in. (50 mV/cm); 1 V/in. (0.5 V/cm); or 10 V/in. (5 V/cm).
3.	Input Resistance:	1 megohm, all calibrated ranges. In VARIABLE, 11K ohms in 1 mV/in. (0.5 mV/cm and 10 mV/in. (5 mV/cm). All other VARIABLE ranges offer 1 megohm input resistance. Potentiometric input impedance (100 megohms nominally) can be achieved on two lowest ranges by removal of one resistor, each axis.
4.	Input Circuit, Each Axis:	Guarded, differential, and floating.

5. Common Mode Rejection (Note 9):	DC	Line Frequency
a. 1 mV/in. (0.5 mV/cm):	130 db	110 db
b. 10 mV/in. (5 mV/cm):	110 db	90 db
c. 100 mV/in. (50 mV/cm):	90 db	70 db
d. 1 V/in. (0.5 V/cm):	70 db	50 db
e. 10 V/in. (5 V/cm):	50 db	30 db

6.	Maximum Common Mode Voltage:	500 Vdc or peak ac.

B. OUTPUT CHARACTERISTICS

1.	Accuracy (Note 1):	±0.2% of full scale
a.	Repeatability (Note 2):	±0.1% of full scale
b.	Linearity (Note 3):	±0.1% of full scale
c.	Dead Band (Note 4):	±0.1% of full scale
2.	Frequency Response (Note 5):	DC to 5 Hz, ±3 db.
3.	Transient Response (Note 6):	
a.	Delay Time (Note 7):	100 milliseconds, maximum
b.	Slewing Speed (Note 8):	X-axis: 30 in./sec (75 cm/sec), typical at 115 Vac, 60 Hz. Y-axis: 20 in./sec (50 cm/sec), typical at 115 Vac, 60 Hz.
c.	Overshoot:	2% of full scale, maximum.
4.	Zero Offset Range:	Plus or minus full scale minimum, from lower left corner of graph, each axis.

C. TIME BASE

1.	Sweep Rates:	0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2 in./sec (0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5 cm/sec).
2.	Accuracy:	±2% of full scale, all rates (10 to 40°C) ±1% of full scale, all rates (20 to 30°C).
3.	Linearity:	±1% of full scale.

D. POWER REQUIREMENTS

1.	Line Voltage:	115 ±10 Vac/230 ±20 Vac, selectable with internal slide switch.
2.	Fuse:	1.5 A for 115 Vac 0.75 A for 230 Vac.
3.	Line Frequency:	48 to 62 Hz.
4.	Power Consumption:	45 watts, typical at 115 Vac, 60 Hz.

E. ENVIRONMENTAL

1.	Operating Temperature:	50 to 104° F (10 to 40° C).
2.	Storage Temperature:	-4 to 158° F (-20 to 70° C).
3.	Relative Humidity (Note 10):	75% maximum.

F. PHYSICAL DESCRIPTION

1.	Dimensions (See Figure 2-1):	17-1/2 in. (44.5 cm) high 19 in. (48.3 cm) wide 5 in. (15.2 cm) deep.
2.	Weight:	Recorder: 27.5 lb (12.5 kg) Accessories: 3 lb (1.4 kg).
3.	Graph Size:	10 x 15 in. and 7 x 10 in. (25 x 38 cm and 18 x 25 cm).
4.	Paper Size:	11 x 16-1/2 in. and 8-1/2 x 11 in. (28 x 42 cm and 21.6 x 28 cm).

NOTES

1. Absolute accuracy over the temperature range and line voltage range, and up to 2 inches (5 centimeters) per second of writing speed.
2. Repeatability is measured with identically repeated input signals with no other change in test conditions.
3. Independent linearity: best straight line.
4. Dead band is the summation of all effects that cause a difference in an output position when that position is approached from opposite directions.
5. Frequency response is measured with a sine wave referred to 1 inch (2 centimeters) deflection.
6. Transient response is measured with an input step voltage of amplitude to cause 10 inches (25 centimeters) deflection.
7. Delay time is the time required to reach 10% of the output amplitude.

8. Slewing speed is calculated from the slope of the linear (constant velocity) portion of the output trace. Slewing speed is proportional to both power line voltage and frequency.

9. Common mode rejection is measured with a 1K ohm resistor between HIGH and LOW, a signal generator between GND and HIGH, and GUARD connected to HIGH.

10. Relative humidity above 70% or below 30% may cause up to 1% error in the graph paper accuracy.

11. Paper holddown force is that force required to move the graph paper along a plane parallel to the plotting surface.

SECTION 2
INSTALLATION

2-1. GENERAL

The Model 530 X-Y Recorder is packaged and shipped in a single carton if ordered individually or shipped in a rack if it is a component part of a system.

2-2. UNPACKING AND HANDLING

Use reasonable care when unpacking the recorder. The recorder is carefully inspected both mechanically and electrically before shipment. After unpacking, visually inspect for dents, bent panels, cracked or broken control knobs or connectors. Remove the bottom cover and inspect the circuit card for cracked or bent components. Immediately report any damage to the carrier agency and to your Esterline Angus Sales Representative.

B. REPACKING

If the original shipping carton is not available, repackage the recorder for shipment as follows:

1. Remove the pen assemblies; secure them in a separate package and pack with the recorder.

2. Secure the carriage with tape to prevent any carriage movement.

3. Enclose the recorder in a plastic bag or sheet to prevent packaging materials from entering the recorder housing.

4. Place the recorder in a heavy duty corrugated cardboard carton having approximately the same inner dimensions as the recorder.

5. Pack dunnage, rubberized horsehair, or air bubble on all sides of the recorder so that all open spaces are filled and tightly packed.

6. Seal the inner carton and place it in an extra strength outer carton. The outer carton must be large enough to allow a minimum of two inches for dunnage on all sides of the inner pack.

7. Be sure dunnage is packed tightly and that no voids remain.

8. Seal the container with strong tape or metal bands. Mark the package "DELICATE INSTRUMENT - FRAGILE."

Note

If approval has been obtained to return an instrument to the factory for service or repair, attach a tag to the instrument identifying the owner, and indicate the work requested. Include the model and serial numbers of the instrument. In any correspondence, always, identify the instrument by model and serial number.

2-3. INSTALLATION

Installation of the recorder consists of mounting (if used in an equipment rack) and making the necessary power and signal connections. Refer to Figure 2-1 for outline dimensions.

The recorder may be operated from any horizontal surface. A retractable tilt bale can be extended from the recorder rear cover to tilt the recorder at a convenient operating angle, if desired.

To rack mount the recorder, obtain a rack mounting kit. Refer to Figure 2-2. Assemble rack mounting flanges (2) and ears (1). Secure the rack mounting flanges at the desired position in the equipment rack with screws (3). Slip the recorder onto the mounting ears. Secure with set screws (4) on each side of recorder.

2-4. CONNECTIONS

A. POWER

Ensure that the ground wire in the recorder power cord is connected to power ground at the receptacle and that a satisfactory earth ground exists at the power receptacle to be used.

1. Remove the bottom cover of the recorder.

2. Locate slide switch S6 on the printed circuit board, and set the switch to the desired position (115 or 230 Vac).

3. For 230 Vac, insert 0.75 A Slo-Blo fuse. For 115 Vac, insert 1.5 A Slo-Blo fuse.

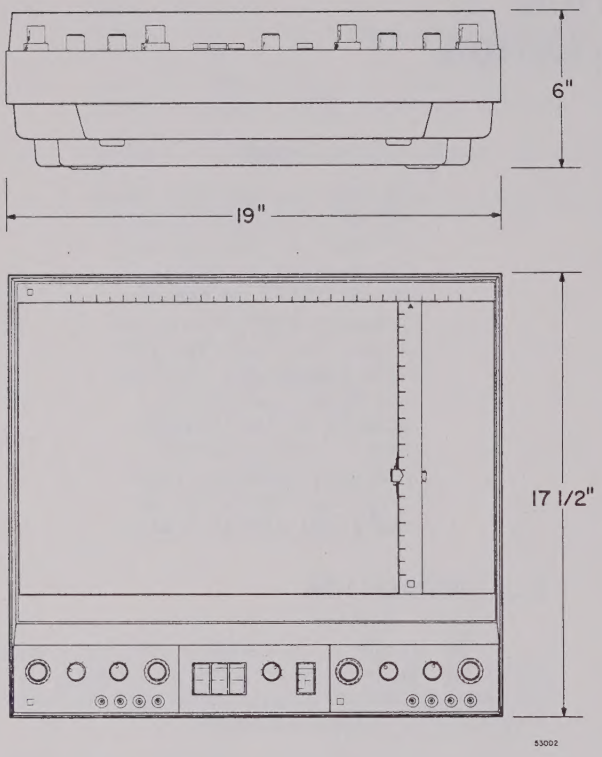


Figure 2-1. Outline Dimensions

B. SIGNAL INPUT AND GROUNDING

The input signal common terminal (LOW) is isolated from chassis ground in the recorder to permit floating measurements. Signal commons of the X and Y inputs are also isolated from each other to provide alternate methods of input signal ground termination. Figure 2-3 shows the differential input connections. This connection is recommended to minimize noise when long cables are used, or when common mode voltages are encountered.

Figure 2-4 shows single-ended input connections. If the signal source low and signal source ground are common, the jumper between LOW and GND on the recorder should not be installed. The GND terminal is connected inside the recorder to chassis and power line ground.

C. REMOTE CONTROL CONNECTIONS (Refer to Figure 6-18)

The pen and the event markers may be controlled remotely through remote connector J1. It is also possible to use an external reference through J1 when this option is installed. J1 is accessible through an opening in the bottom cover.

Note

The GUARD terminal must connect to the signal source ground or to the recorder LOW terminal. The GUARD terminal should never be left floating.

1. Pen

The pen may be lowered and raised with an external switch connected through the remote connector. Closure of a pair of contacts between pins 4 and 5 of J1 drops the pen. An open between pins 4 and 5 of J1 raises the pen. For remote operation, the PEN switch must be in the UP position.

2. Time Base

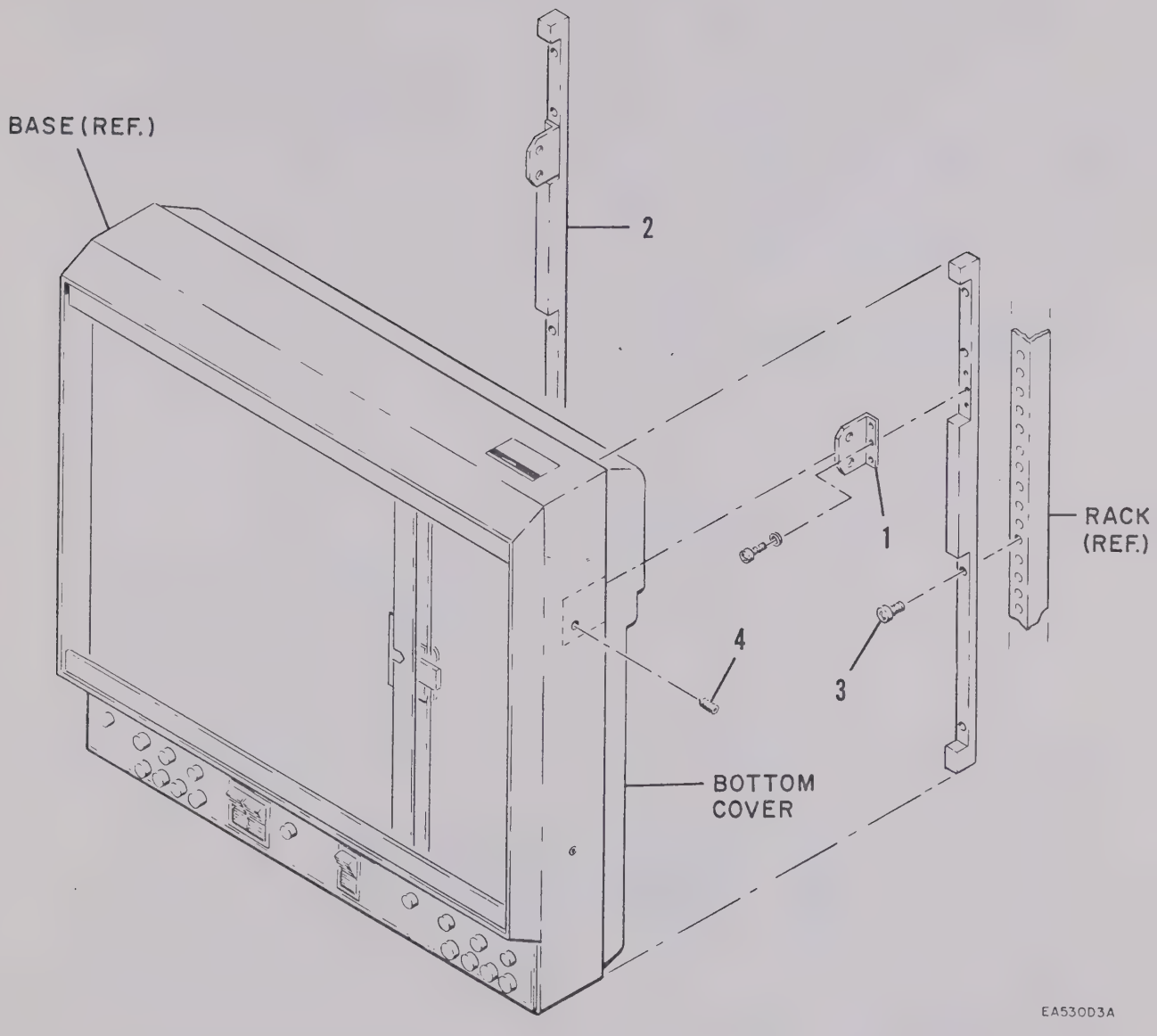
The optional time base circuit may be remotely started and stopped with an external switch. Shorting pins 12 and 13 of J1 resets the time base; an open circuit between these two pins starts the time base. For remote operation, the front panel SWEEP switch must be in the START position.

3. Event Marker

Event marks may be recorded by applying external pulses through remote connector (J1). A pulse applied between pins 15 and 16 records an event on the X-axis. A pulse applied between pins 9 and 10 records an event mark on the Y-axis. The sensitivity is 5 V/in. (2 V/cm), and the input resistance is 10K ohms. A positive going pulse produces a negative deflection of the pen.

4. External Reference

When the optional external reference circuit is installed, an external reference voltage may be used instead of the internal reference. Refer to Figure 6-18 for the connections to make through remote connector (J1). Slide switches (9, Figure 5-8) on the circuit board provide switching between internal and external reference.



1. Rack Mounting Ear
2. Rack Mounting Flange
3. Flange Mounting Screw (6)
4. Set Screw (2)

Figure 2-2. Rack Mounting

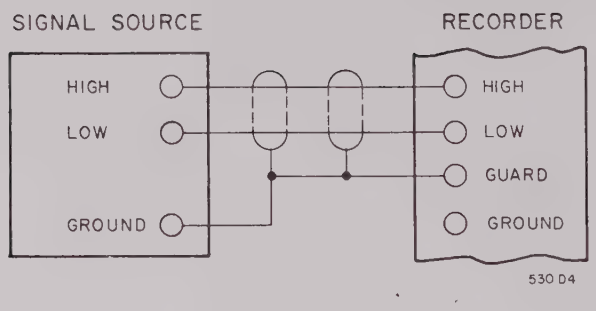


Figure 2-3. Differential Input Connection

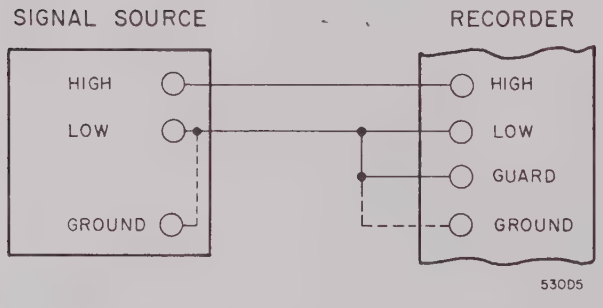


Figure 2-4. Single-Ended Input Connection

SECTION 3
OPERATION

3-1. GENERAL

This section describes the controls and operating procedure of the Model 530 Series Recorders. Thoroughly acquaint yourself with the function of each control and the proper operating procedure.

3-2. CONTROLS AND CONNECTIONS

The front panel controls and connectors are shown and described in Figure 3-1. A connector for remote operation is located on the circuit board assembly (see paragraph 2-4, C).

3-3. PREOPERATIONAL PROCEDURES

A. GENERAL

Noisy input signals or improper grounding at the input may result in unpredictable fluctuations in the recorder. If this condition is allowed to persist, it will cause excessive wear in the followup potentiometers. Mechanical stops and a slip clutch are provided to prevent damage to the drive mechanism or the followup potentiometers if an overrange signal is applied to the input terminals.

The slip clutches emit an audible alarm to alert the operator to correct an overrange condition. Do not permit clutches to slip for long periods of time.

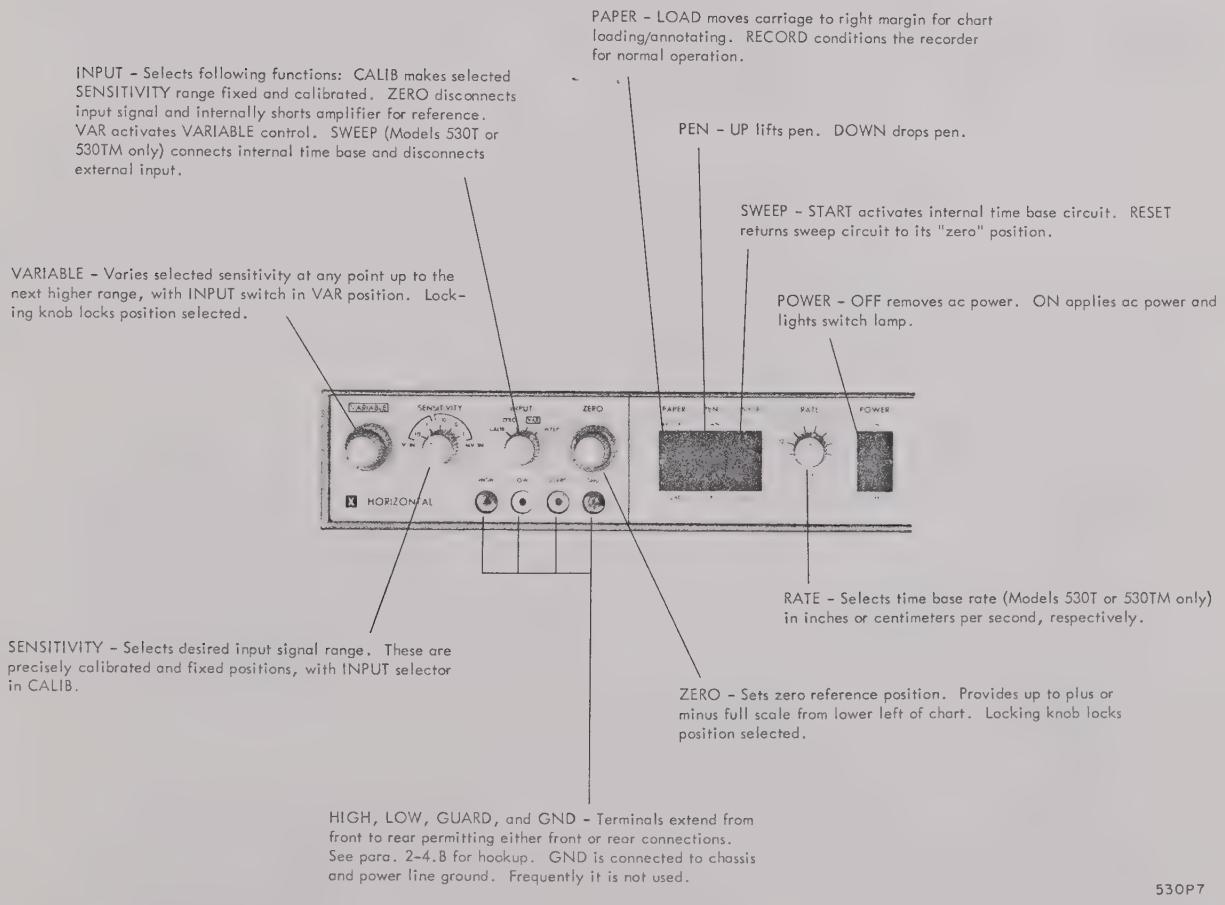

PAPER - LOAD moves carriage to right margin for chart loading/annotating. RECORD conditions the recorder for normal operation.
INPUT - Selects following functions: CALIB makes selected SENSITIVITY range fixed and calibrated. ZERO disconnects input signal and internally shorts amplifier for reference. VAR activates VARIABLE control. SWEEP (Models 530T or 530TM only) connects internal time base and disconnects external input.
PEN - UP lifts pen. DOWN drops pen.
SWEEP - START activates internal time base circuit. RESET returns sweep circuit to its "zero" position.
VARIABLE - Varies selected sensitivity at any point up to the next higher range, with INPUT switch in VAR position. Locking knob locks position selected.
POWER - OFF removes ac power. ON applies ac power and lights switch lamp.
RATE - Selects time base rate (Models 530T or 530TM only) in inches or centimeters per second, respectively.
SENSITIVITY - Selects desired input signal range. These are precisely calibrated and fixed positions, with INPUT selector in CALIB.
ZERO - Sets zero reference position. Provides up to plus or minus full scale from lower left of chart. Locking knob locks position selected.
HIGH, LOW, GUARD, and GND - Terminals extend from front to rear permitting either front or rear connections. See para. 2-4.B for hookup. GND is connected to chassis and power line ground. Frequently it is not used.
530P7

Figure 3-1. Model 530 X-Y Recorder Operating Controls

CAUTION

In the 1 mV/in. and 10 mV/in. (0.5 mV/cm and 5 mV/cm) ranges, the input to any axis must not exceed 10 volts. The maximum input for all other ranges is 500 volts.

B. PEN INSTALLATION

The inking system consists of a disposable ink cartridge with a fiber-tip marker. The cartridge snaps into clips of a bracket located on the slider, below the carriage cover. This bracket, which also supports the pen-pointer arrow, can be removed during installation of a marker cartridge, if desired.

CAUTION

Do not bend or twist spring portion of pen bracket assembly.

1. Initial Cartridge Installation

Removal of the pen bracket assembly is not required as part of the cartridge installation procedure; however, if removal is desired, the bracket should be carefully slid outward toward the left. To accomplish this, press inward on the slotted arms at the rear of the bracket to loosen it from the three shouldered standoffs on the carriage slider, then pull straight forward from the left and remove the entire bracket.

Cartridges are shipped with caps over the fiber marker tip. Remove this cap prior to inserting the cartridge in the bracket. Snap the cartridge into the clips at the bottom of the bracket with the marker facing outward. If the bracket was removed from the instrument, replace it by carefully aligning the bracket slots with the three shouldered standoffs on the carriage slider then slowly press the bracket inward until the end of the slots seat under the standoffs. The arrow pointer must be above the scale decal.

2. Changing Cartridges

Remove the old ink cartridge by pulling straight outward from the left. Remove the protective cap from the new cartridge and snap the cartridge into the clips at the bottom of the pen bracket assembly. Ensure that the cartridge is positioned snugly against the bracket. If preferred the bracket may be removed prior to replacing the cartridge (refer to "Initial Cartridge Installation").

3. Pen Care

The fiber-tip disposable marker provides a neat, clean inking system. Clogging, blotting, priming, skipping, and the necessity for cleaning have been eliminated. The only maintenance required is that of maintaining a stylus force of approximately 8 to 12 grams maximum to insure optimum cartridge life and minimum tip wear.

The marker tip cap need not be replaced if the recorder is not used overnight. However, it is advisable to replace the cap to prevent drying out if the recorder is not to be used for several days. Should the marker fail to write after periods of non-use, ink flow can often be started by moistening the marker tip.

C. PAPER LOADING

Insert a sheet of graph paper in the recorder by setting the POWER switch to LOAD. This moves the carriage to the extreme right. Align the paper against the stop on the bottom of the plotting area. Position the large size graph paper against the paper stop at the left side of the plotting area. The small size paper should be aligned with the vertical index line near the left side of the plotting area.

3-4. OPERATING PROCEDURE

A. RECORD MODE

1. Set the POWER switch to OFF, and connect the power cord to a suitable ac outlet. Ensure that the receptacle ground has been verified. Do not connect the signal inputs.

2. Set the POWER switch to ON. Insert graph paper according to the instructions in paragraph 3-3, C.

3. Turn the INPUT switch to ZERO and adjust the ZERO controls to position the carriage and pen at the lower left corner of the graph or any other desired zero reference point. Use the locking rings to hold this adjustment.

Note

On the 1 mV/in. (0.5 mV/cm) and 10 mV/in. (5 mV/cm) ranges the pen position may become erratic and unpredictable, if the input terminals to the recorder are left open. Under this condition, the input side of the recorder amplifier is open and no point of comparison with the internal reference is established.

4. Set the INPUT switches to CALIB and the SENSITIVITY switches to provide for deflections corresponding to the maximum voltages to be recorded. If the ZERO control for any axis has been used to establish an offset or suppressed zero, a more sensitive range setting may be useful for that axis. Refer to step 7.

CAUTION

Be careful not to exceed the maximum allowable input voltage. If the amplitude of the input signal is not known, set the SENSITIVITY switch to the least sensitive position 10 V/in. (5 V/cm). An adjustment for greater sensitivity can be made after the signal has been observed in step 6.

5. If it is desired to have recorder sensitivity correspond exactly to the setting of the SENSITIVITY switches, leave the INPUT switch in CALIB.

If the desired sensitivity is intermediate between the fixed SENSITIVITY settings, set the SENSITIVITY switch to the more sensitive position and place the INPUT switch to VAR. The ten-turn VARIABLE control potentiometer may then be used to continuously decrease the sensitivity up to a factor of 10.

6. Connect the input signals. The pens and carriage follow the signal variations, but the pens are not lowered to the paper.

Note

A positive dc signal drives the horizontal X-axis to the right and the vertical Y-axis up.

7. If the signal input voltages are greater than the settings of the SENSITIVITY controls and the desired information is off the recording area, the ZERO controls can be used effectively to select only the desired portion of the input signal and reject the unwanted portion. With these controls in the extreme counterclockwise positions, negative voltage offsets equal to full scale are provided for recording voltages that vary about high positive dc levels. By means of the ZERO offsets, the effective recording area can be quadrupled.

8. Lower the pen and begin recording by setting the PEN switch to the DOWN position.

B. SWEEP MODE

In Models 530T and 530TM, either axis may be used as a time base, when SWEEP is selected by the front panel INPUT selector switch. The other axis, operating in the record mode, is referred to as the signal axis.

1. Perform steps 1 and 2 of paragraph 3-4, A.

2. Set the INPUT selector switch to SWEEP, on the axis selected for time base operation.

3. Set the PAPER switch to RECORD and the SWEEP switch to RESET.

4. Set the SENSITIVITY and VARIABLE controls for the signal axis per paragraph 3-4, A.

5. Set the RATE switch to the desired setting.

6. Adjust the ZERO controls according to step 3 of paragraph 3-4, A.

7. Connect the input signal to the appropriate jacks. The signal axis begins to follow the input variations. The SWEEP axis remains at its zero position.

8. Set the SWEEP switch to START and the PEN switch to DOWN simultaneously. The pen drops and begins plotting the external signal, as a function of time from the internal time base.

9. When the time base axis reaches a point where it is desired to reset the sweep, return the SWEEP switch to RESET and the PEN switch to UP simultaneously. This lifts the pen and returns the time base axis to its zero position.

Note

At the end of a sweep if the pen is not raised as the sweep is reset, a retrace occurs on the graph paper.

Note

To avoid wear on the slip clutch, reset the sweep circuit as soon as the sweep is completed.

C. REMOTE CONTROL OPERATION

The connections and procedures required for remote control operation are discussed in paragraph 2-4, C.

D. POTENTIOMETRIC OPERATION

In applications where higher recorder input impedance is desirable, the recorder can be modified for potentiometric operation in the 1 mV/in. (0.5 mV/cm) and 10 mV/in. (5 mV/cm) SENSITIVITY ranges. Remove R102 for X-axis and R202 for Y-axis per Note 3, Figure 6-18. In potentiometric operation, the input impedance is 100 megohms minimum.

SECTION 4
PRINCIPLES OF OPERATION

4-1. GENERAL

This section describes the operating principles for the Model 530 Series X-Y Recorders to aid you in operating and maintaining the recorder. A functional description, together with a block diagram (Figure 4-1), shows the interrelationship of each major function. Each function is then described in logical sequence using simplified schematics or block diagrams as necessary. Refer to Figure 6-15 for circuit card component locations and to Figure 6-18 for the overall schematic diagram.

4-2. FUNCTIONAL DESCRIPTION

The recorder plots the relationship of two independent input signals on a two-axis graph (Y or vertical, and X or horizontal axes). The circuits for both axes are identical, so only one axis is described. Refer to Figure 4-1, a functional block diagram of the circuitry for each axis of the recorder.

The signal input voltage to be recorded is applied through the input attenuator and selector to the servo amplifier. The resulting signal voltage is compared with an internal reference voltage, producing a difference or error voltage. The error voltage is applied to the servo amplifier. The servo amplifier conditions and amplifies the error voltage to drive the servo motor. The servo motor moves the pen through a cable drive system and rotates a mechanically coupled followup potentiometer in the required direction to reduce the error voltage to a minimum, thus obtaining a balance or null condition. The error voltage is reduced to a minimum by a feedback voltage proportional to the actual position of the pen with respect to its zero position. This feedback is routed from the followup potentiometer through the attenuator to the servo amplifier comparator. Any change in the signal input voltage causes the pen to move proportionally and establish a new balance point.

The feedback voltage is also changed by the front panel ZERO control, which is used to position the zero reference point any place on the recording area. Both the zero offset and the followup potentiometer obtain their voltage from a precision, Zener-referenced power supply.

4-3. CIRCUIT DESCRIPTION

A. INPUT SELECTOR

The input selector switch selects one of four signal voltages for the servo amplifier.

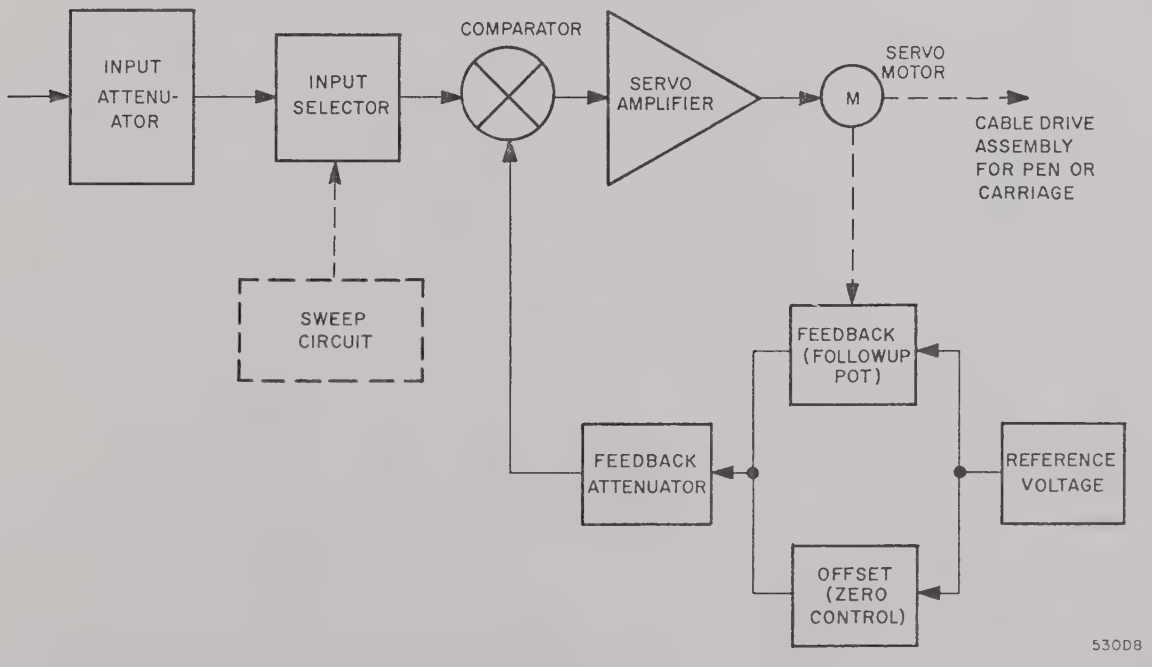


Figure 4-1. Block Diagram of Servo System (Each Axis)

1. Calibrated Ranges

With the INPUT switch in CALIBrate, one of five fixed sensitivity ranges is selectable by the SENSITIVITY switch. This switch controls both the input attenuator (Figure 4-2) and the feedback attenuator (Figure 4-3). The feedback attenuator sets the axis basic sensitivity to either 1 mV/in. (0.5 mV/cm) or 10 mV/in. (5 mV/cm). The input attenuator provides precision attenuation of 100 or 10,000. The input attenuation and the axis sensitivity are shown for each range in Table 4-1.

2. Zero Check

With the INPUT switch in the ZERO position the input to the servo amplifier is shorted to common.

3. Variable Ranges

With the INPUT switch set at VAR, the sensitivity may be adjusted by means of a panel VARIABLE control from 1 to 0.1 of the value indicated on the SENSITIVITY switch.

On ranges 1 mV/in. (0.5 mV/cm) and 10 mV/in. or (5 mV/cm), the signal is routed directly to the 10 K precision multiturn VARIABLE potentioneter (see Figure 4-4).

Ranges 100 mV/in. (50 mV/cm) and 1 V/in. (0.5 V/cm) have the voltage across the 10 K potentiometer attenuated by 100 referred to the input voltage. The voltage across the 10 K potentiometer in the 10 V/in. (5 V/cm) range is 1/10,000 of the input voltage.

4. Sweep Mode (Models 530T and 530TM)

When operating in the SWEEP mode, (S102) sections A and B (see Figure 6-18) pick up the sweep circuit output and reference the sweep circuitry to the axis common, and section C forces the axis sensitivity to 10 mV/in. (5 mV/cm). When operating in the record mode, the sensitivity (section C) is controlled by the SENSITIVITY switch (S101).

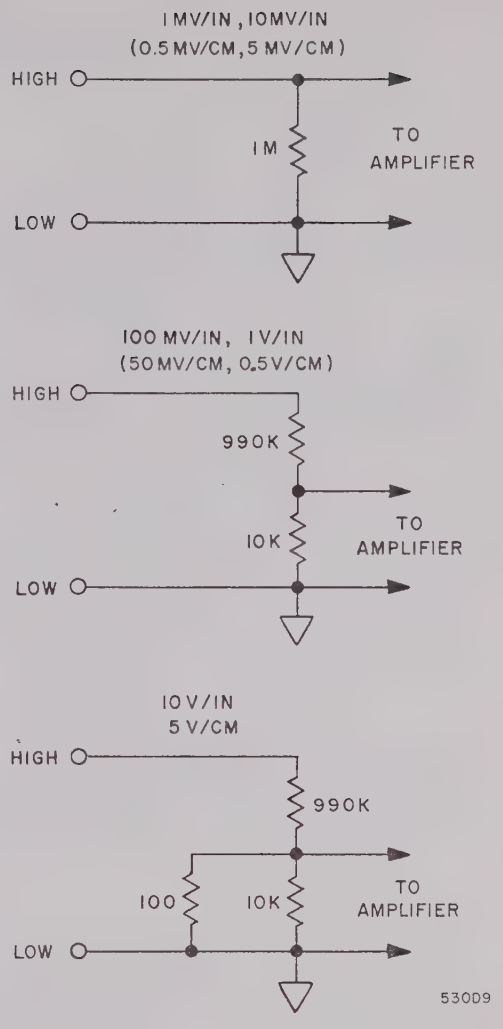


Figure 4-2. Input Attenuator (Simplified)

B. SERVO AMPLIFIER

The servo amplifier consists of the comparator, the integrated amplifier, the power amplifier, and the feedback circuit (Figure 4-5).

Table 4-1. Input Attenuation and Axis Sensitivity

RANGE		ATTENUATION	AMPLIFIER SENSITIVITY	
INCHES	METRIC		INCHES	METRIC
1 mV/in.	0.5 mV/cm	1:1	1 mV/in.	0.5 mV/cm
10 mV/in.	5 mV/cm	1:1	10 mV/in.	5 mV/cm
100 mV/in.	50 mV/cm	100:1	1 mV/in.	0.5 mV/cm
1 V/in.	0.5 V/cm	100:1	10 mV/in.	5 mV/cm
10 V/in.	5 V/cm	10,000:1	1 mV/in.	0.5 mV/cm

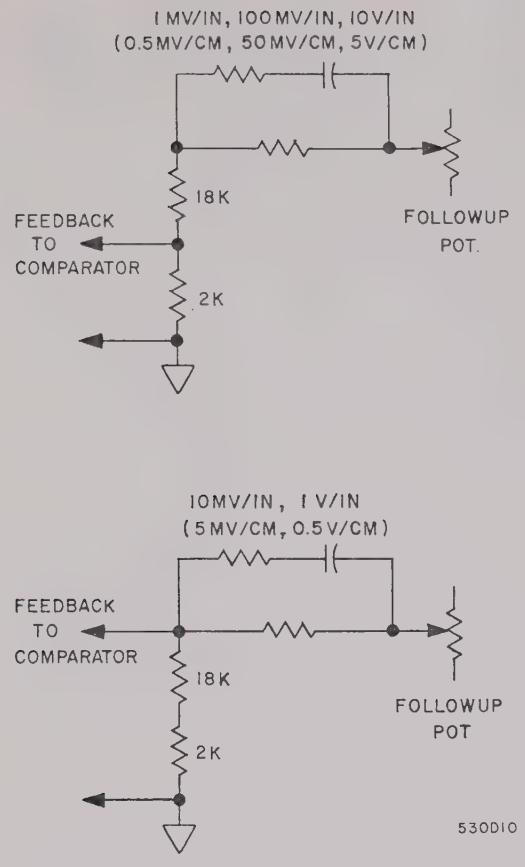


Figure 4-3. Feedback Attenuator (Simplified)

1. Comparator

This section includes transistors Q101, Q102, and associated circuitry. Q101 is a monolithic dual silicon transistor that functions in the circuit as a differential amplifier. When there is a null, the input voltage and the feedback voltage are equal and no output (voltage difference) is produced at the collectors. An error voltage is produced when the input or feedback voltages change, causing the motor to move in a direction that reduces the error. Q102, a dual matched transistor, buffers the collector load resistors (R114 and R115) of Q101 from the input impedance of the following amplifier (Z101) allowing high voltage gain to be realized in this stage.

Potentiometer R113 removes the offset voltage from Q101 and the following stages. Potentiometer R110 supplies base currents to Q101 through resistors R108 and R109.

2. Integrated Amplifier

Amplifier Z101 is a linear integrated circuit amplifier (μA709C) used to provide additional gain for the servo amplifier. Frequency stabilization for the servo amplifier is provided by capacitors C104, C105, and resistor R119.

3. Power Amplifier

Error signals from the integrated amplifier Z101 are used to drive the power amplifier, comprised of transistors Q103, Q104, Q105 and Q106. The power amplifier operates class AB thus requiring little idling current but having the capability of delivering up to 1 ampere to drive the servo motor.

Resistors R120 and R121 and diodes CR106 and CR107 bias transistors Q103 and Q104 into slight conduction, and the biased transistors drive the power transistors Q105 and Q106. Resistors R124 and R125 provide local feedback around the power amplifier to stabilize the gain and reduce the output impedance.

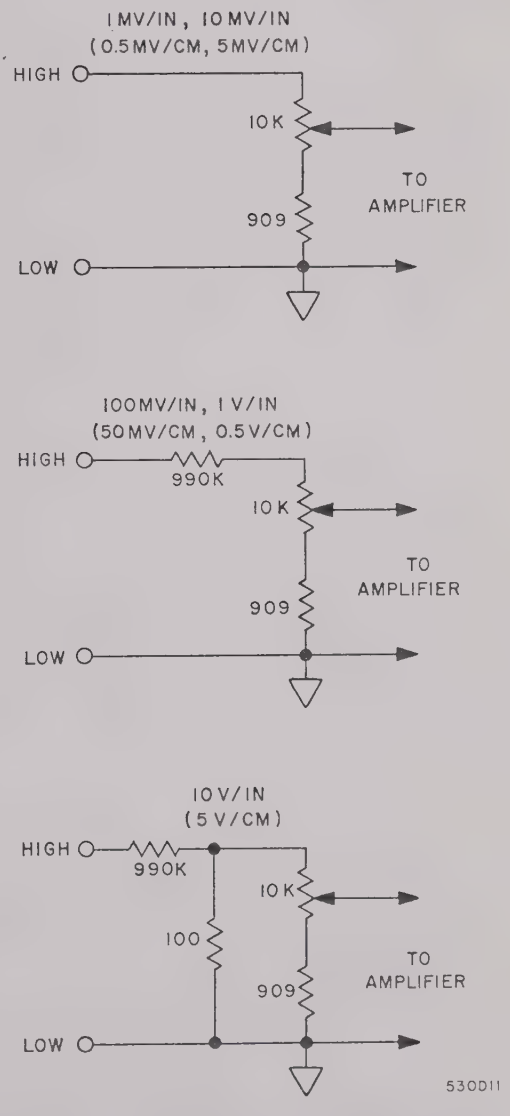


Figure 4-4. Input Attenuator with VARIABLE Potentiometer

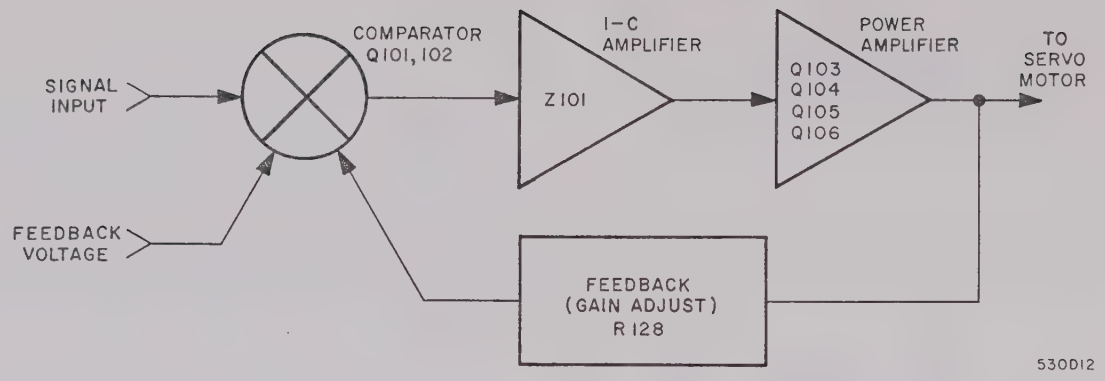


Figure 4-5. Servo Amplifier Block Diagram

4. Feedback

Feedback around the entire servo amplifier derived from resistors R126, R127, R146, R153, potentiometer R128, and C114 further reduces the output impedance and secures good dynamic performance from the servo motor.

C. SERVO MOTOR

The low inertia dc motor is driven by the servo amplifier, the phase of the drive voltage determining the direction of rotation and the magnitude of the voltage determining the speed of rotation.

D. POWER SUPPLIES

Diodes CR116, CR117, CR118, and CR119 supply unfiltered voltage to the power amplifier directly from a shielded secondary of power transformer T1. Unregulated ±22 volts is obtained from the secondary winding, and full wave capacitor input filters (CR112, CR113, CR114, CR115, C108 and C109). Zener (CR110, CR111) preregulated voltages (±15 V) supply the reference zeners (±9 V); also 15 volts is used in the PAPER LOAD circuit (X-axis). Another winding on the power transformer supplies (by means of a half-wave capacitor input filter) power to the pen solenoid (and to the sweep circuit on Models 530T and 530TM).

E. REFERENCE VOLTAGE

The preregulated voltage (paragraph 4-3, D) is used to supply the temperature compensate sated zeners (CR108, CR109). The zeners supply a stable ±9 volts to the followup and the ZERO offset potentiometers, which drive the feedback attenuator (Figure 4-1).

F. FEEDBACK (FOLLOWUP) POTENTIOMETERS

The precision three-turn followup potentiometer (Figure 4-1) is mechanically coupled to the servo motor, and is driven by the motor in the direction that reduces (nulls) the error signal.

G. ZERO OFFSET CONTROL

The offset ZERO potentiometer (Figure 4-1) is a front panel control used to introduce an offset (error) voltage into the feedback circuit. The recorder responds to the error voltage in the same manner as an input signal. The ZERO control provides the means for positioning the zero point at any place on the recording area.

H. PAPER LOAD CIRCUIT

See Figure 4-6. With the PAPER switch in the RECORD position, the output of the μA709C is applied to the X-axis servo motor driver amplifier for normal record operation. Also the 50 μF capacitor is charged to 15 volts through the 2.2 K resistor.

When the switch is set to LOAD, the normal signal is replaced with a 15 volt, 2.5 second (RC time constant) signal. This signal causes the carriage to move to the right margin to facilitate paper loading or graph paper notations.

I. GUARD

The GUARD is used to minimize the effects of common mode voltages such as those encountered when measuring low level signals from thermocouples and strain gages. The circuitry shown in Figure 4-1 is all within the guarded section (except the SWEEP circuit) and is shielded from ground by the conductive GUARD. When the GUARD is connected to the signal source ground, the effective capacitance from the input circuitry to ground is minimized; hence, the common mode current and any recording error it may produce is greatly reduced.

J. TIME BASE CIRCUIT (530T and 530TM)

The SWEEP function (Figure 4-7) is accomplished by using an operational integrator to produce a linear ramp voltage at the input of the sweep axis amplifier.

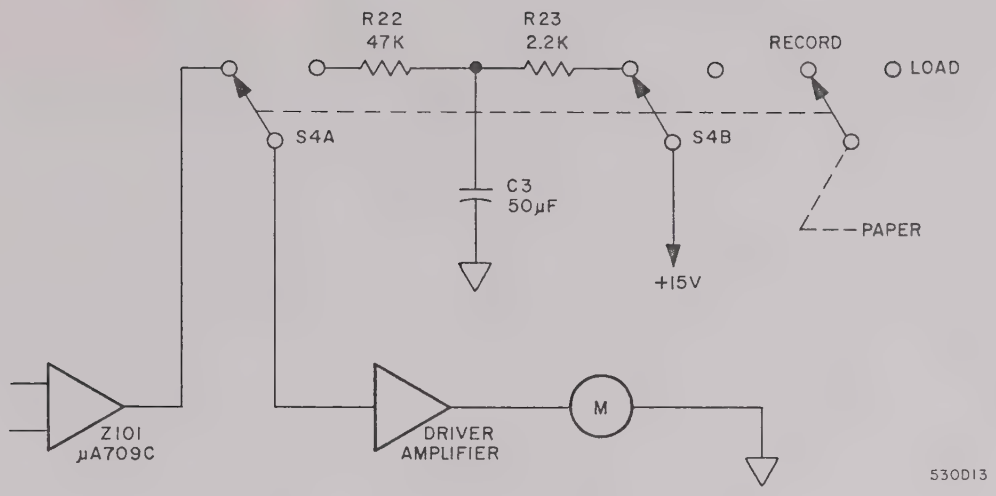


Figure 4-6. Paper Load Circuit (X-Axis only)

The rate of the ramp is determined by the RC time constant of the integrator capacitor, and the rate resistor value selected by the RATE IN/SEC (CM/SEC) switch; increasing the resistance decreases the rate. A voltage divider, in parallel with a Zener diode, provides a fixed potential to the operational integrator. This potential is set by adjusting the sweep CAL (sweep calibration) potentiometer. The output of the sweep integrator is divided by the 1 M, 20 K attenuator and is applied to the sweep axis through the SWEEP position of the INPUT switch.

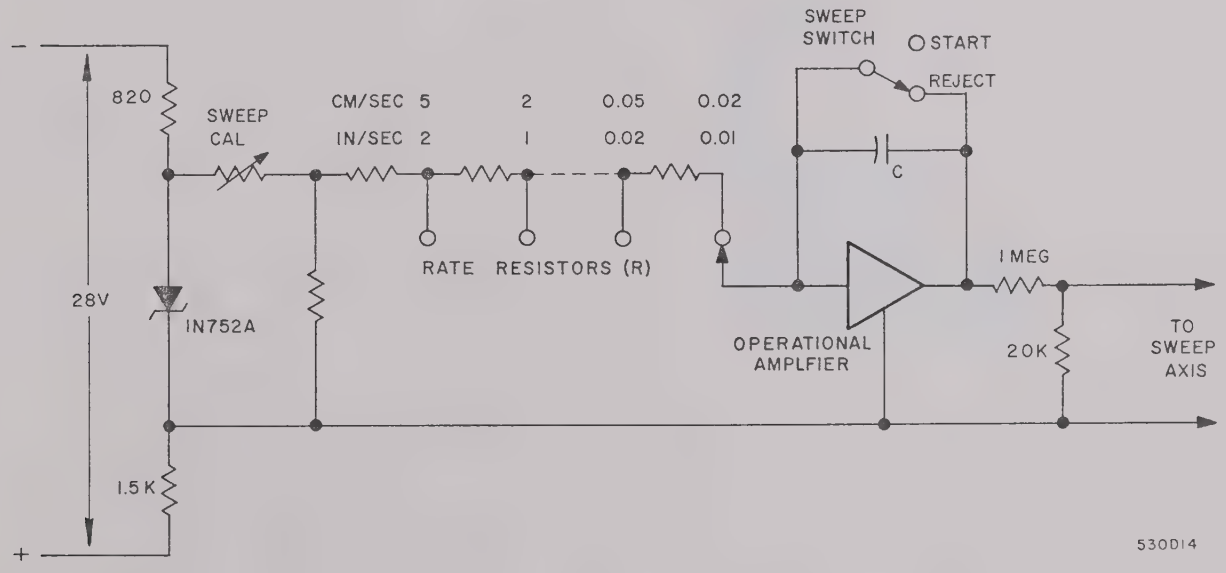


Figure 4-7. Sweep Circuit (Simplified)

SECTION 5
MAINTENANCE

5-1. GENERAL

This section describes preventive and corrective maintenance procedures for the Model 530 Series X-Y Recorders. Preventive maintenance consists of routine procedures performed at regular intervals without special tools or test equipment. Corrective maintenance discusses basic troubleshooting, repair, and replacement of parts. Refer to appropriate parts location illustrations in Section 6 and the schematic diagram (Figure 6-18) as necessary.

5-2. PREVENTIVE MAINTENANCE

A. INSPECTION

Perform an overall visual inspection of the instrument for foreign matter, wear of moving parts, or damage. Check all electrical connectors and mechanical connections. Ensure that all screws, nuts, and bolts are tight.

B. CLEANING

Remove dust and loose dirt from the instrument with a brush, a vacuum hose, or low pressure air. Remove deposits of dirt, grease, or oil from metallic parts with a cloth moistened with a commercial dry cleaning solvent (petroleum solvent). Clean nonmetallic parts with a lint-free cloth moistened with plain water.

Clean the cable drive system about every six months. Part of the cable system is located between the plotting surface and the circuit board. For access to this part of the cable system and both sides of the circuit board, disassemble as follows:

1. Remove all signal and power connections from the recorder.
2. Remove all knobs from the control panel.
3. Remove the bottom cover,and place the recorder on a maintenance stand (Figure 5-1).
4. Release the circuit board by removing five screws, two on each of the outside edges and one at the center top. Tilt out the circuit board as shown in Figure 5-1.

C. LUBRICATION

CAUTION

Do not lubricate pulleys, cables, or gears in the cable drive system.

All cable pulleys contain shielded ball bearings that require little or no lubrication. Lubrication is required only on fan motor bearings. Place one drop of oil on each of two felt pads adjacent to the bearings twice per year. Wipe off excess oil.

D. ADJUSTMENTS

Perform the following adjustments when indicated by visual inspection or recorder performance.

1. Cable Tension

Adjustment is required if the cables become loose or after component replacements that required the cables to be loosened.

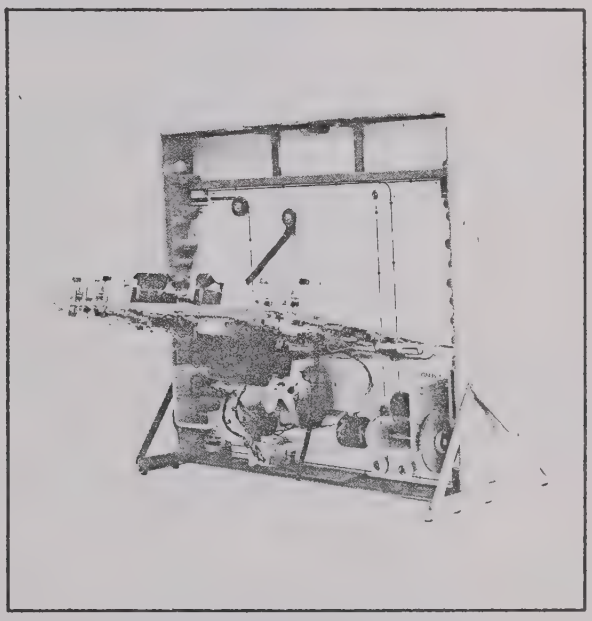


Figure 5-1. Circuit Board Shown in Maintenance Position.

a. Adjust cable tension on each axis by loosening the cable holddown screw, then retracting or extending the cable.

b. Check for any binding or restriction of travel in the pen trolley or carriage. Tension of the cables should be tight enough to prevent cables from slipping off the pulleys, but not tight enough to cause excessive friction or binding. If necessary, adjust per paragraph 5-4, A, 1.

c. If specifications are met with slip clutch loosened, cable tension is correct, and binding is occurring in the gears. Correct per paragraph 5-2, D, 3.

d. If specifications are not met, check for binding followup potentiometer. If necessary, replace per paragraph 5-3, D. 4.

2. Pen Trolley

Adjustment is needed if side or vertical play exists, or after repair.

a. Place the recorder on the service stand and remove the rear cover.

b. Move the pen trolley and carriage to the upper right corner of the plotting area.

c. Position the V-bearing over the access hole in the main table and the subtable.

d. Using a small Phillips screw driver, engage the V-bearing mounting screw through the access hole from the rear.

e. Loosen the mounting screw just enough to permit movement of the V-bearing.

f. Manually position the V-bearing in its elongated hole for proper pen trolley clearance. Proper clearance is when no side or vertical play exists, and the pen trolley does not bind at any point along the slide bar.

g. Tighten the mounting screw. Recheck for proper clearance.

3. Servo Motor Meshing

Adjustment is required after component replacement or if operation is noisy or binding.

a. Loosen four screws (1, Figure 5-2) just enough to permit slight movement of the servo motor (4).

b. Insert a piece of writing paper (0.003-inch thick) between the pinion gear (5) and the spur gear (6).

c. Manually position the servo motor for zero backlash between gears. Tighten the servo motor mounting screws (1).

d. Remove the paper and recheck gear operation.

Note

When gear play is too tight, excess friction occurs. Too much gear play produces wear and noisy operation.

5-3. CORRECTIVE MAINTENANCE

A. GENERAL

If a malfunction is isolated to the recorder, carefully check all leads, connectors, and components for visible damage such as broken leads, burnt or damaged components, or broken solder connections. If this inspection fails to isolate the source of trouble, refer to the subsequent troubleshooting procedures.

B. TEST EQUIPMENT

The following test equipment (or equivalent) is required to troubleshoot and test the recorder:

1. Spring scale with 1/4 ounce (5 grams) resolution from 0 to 16 ounces (460 grams).

2. Variable dc source 0 to 150 volts.

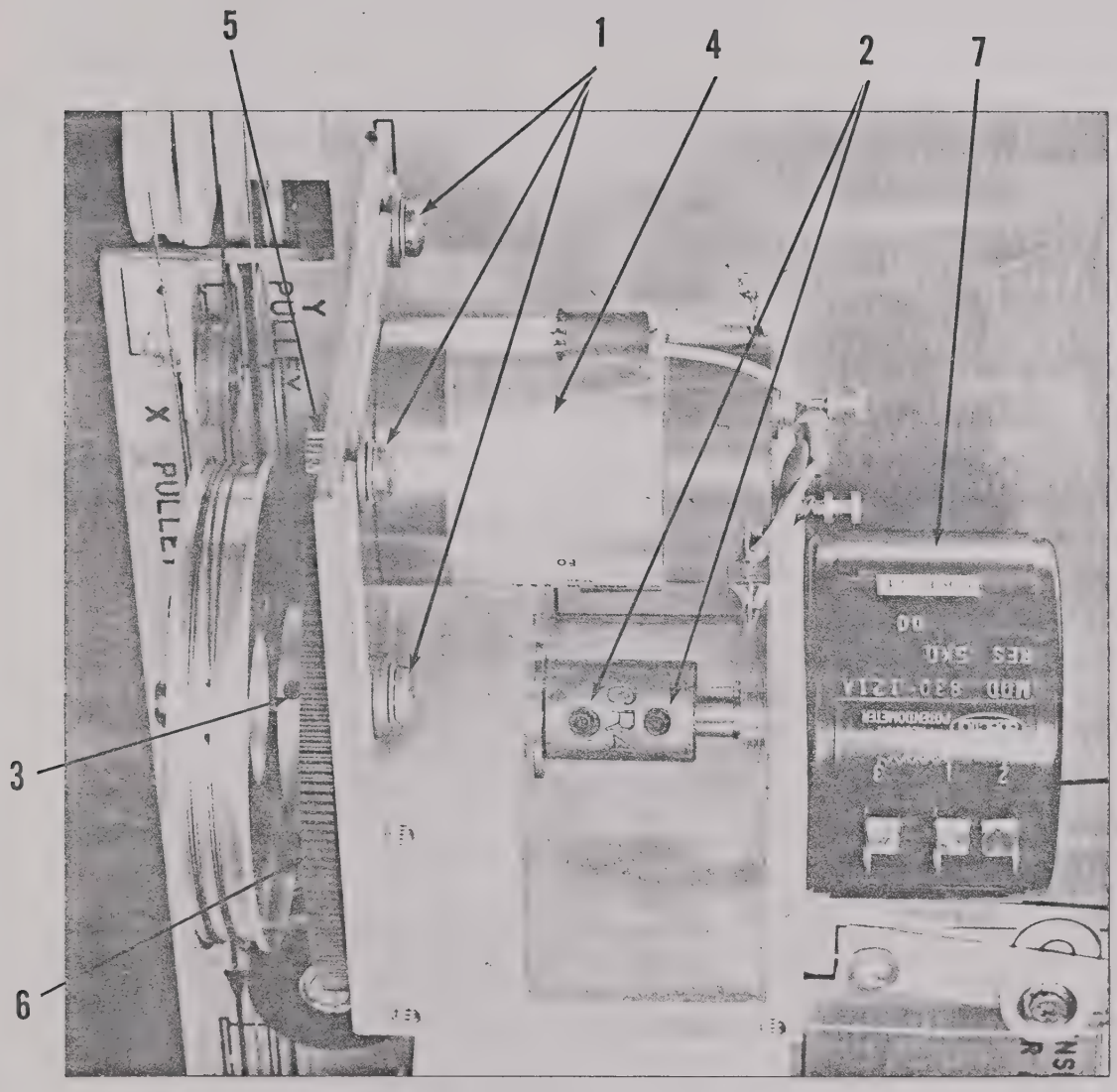
3. Voltmeter used to supplement the variable dc source.

4. Low frequency function generator with frequency range 1 to 100 Hz and 0 to 30 volts peak-to-peak output.

C. TROUBLESHOOTING PROCEDURE

Before troubleshooting the recorder, acquaint yourself with Section 4, Principles of Operation. Remove the bottom cover for troubleshooting. Use the following general guidelines and the Troubleshooting Guide (Table 5-1) to locate the malfunction.

1. Key bias voltages are shown on the schematic diagram (Figure 6-18). These voltages are usually maintained within ±5%,



1. Motor Mount Screws (4, one behind motor)
2. Coupling Set Screws
3. Clutch Adjustment
4. Servo Motor
5. Pinion Gear
6. Spur Gear
7. Follow-up Potentiometer

530P6-2

Figure 5-2. Mechanical Drive Assembly

Table 5-1. Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	SUGGESTED REMEDY
1. Sluggish response to input signals; little resistance to pen or carriage movement; excessive overshoot.	a. GAIN setting too low. b. Axis cables loose	a. Increase GAIN setting. b. Restring cable: VERTICAL axis (paragraph 5-3, D. 6); HORIZONTAL axis (paragraph 5-3, D, 7).
2. Pen or carriage oscillates; excessive jitter.	a. GAIN setting too high. b. Excessive common mode signal. c. Instrument ungrounded.	a. Reduce GAIN setting. b. Connect input cables as in Figure 2-3. c. Ground instrument (paragraph 2-4).
3. Pen does not lower to paper.	a. Improper conditioning of control panel or remote switches. b. Defect in the mechanical linkage between pen solenoid and pen. c. Defective pen solenoid. d. Dried ink or other foreign matter binding pen tip.	a. Review operation procedures in Section 3, and condition recorder accordingly. b. Check linkage for dirt or mechanical binding; clean and repair linkage as required. c. Replace solenoid. d. Clean as necessary.
4. Pen does not write.	a. Exhausted ink supply. b. Dried ink; dirty pen tip.	Replace ink cartridge. Clean and moisten pen tip.
5. Pen Skipping.	a. Dried ink on pen tip. b. Writing speed too fast.	a. Moisten pen tip; replace cartridge. b. Reduce writing speed.
6. Trace is erratic in one or more positions. Positions do not change with ZERO setting.	Defective feedback pot.	Clean or replace, per paragraph 5-3, D, 4.
7. Pronounced deviation in trace; not erratic.	Excessive friction.	Clean bearings and bearing rods. Eliminate any mechanical binding.
8. Servo drives to one end of travel as input signal (less than full scale) is applied. NOTES This symptom can also be caused by a phase reversal due to improper replacement of a faulty component; e.g., motor leads or follow-up potentiometer leads. In normal operation, a servo drives to one end if the input switch is set to CALIB with the input open on the two most sensitive ranges (see NOTE in paragraph 3-4, A).	Loss of feedback voltage: a. Feedback potentiometer open. b. Open circuit at some point between followup potentiometer arm and input to servo amplifier.	a. Replace potentiometer if open is indicated, per paragraph 5-3, D, 4. b. Restore continuity; replace any open component.

Table 5-1. Troubleshooting Guide (Cont'd.)

SYMPTOM	PROBABLE CAUSE	SUGGESTED REMEDY
9. Servo inoperative.	a. Servo motor defective. b. Faulty component in servo amplifier circuitry (Figure 4-5).	a. Replace b. Locate by checking dc levels and by applying identical signals through both servo amplifiers and comparing oscilloscope traces; replace faulty components.
10. Servo drives continuously in one direction.	Faulty component in servo amplifier circuitry (Figure 4-5).	Locate by checking dc levels and by applying identical signals through both servo amplifiers and comparing oscilloscope traces. Replace faulty components.

and are measured with the front panel switches in any position, and the input shorted. Measurements must be made with a high impedance voltmeter, except for the transistor V_{BE} checks (step 5).

2. Observe the proper polarity when making dc voltage checks.

3. V_{BE} is approximately 0.6 volt for a conducting transistor.

4. The voltage across a forward-biased diode should be approximately 0.6 volt.

5. Each recorder is tested and calibrated before shipment. The following assumptions should be made in troubleshooting:

   a. The instrument is wired correctly.

   b. Transistor problems are usually limited to: open, short, and noise.

   c. Diode failures are: open or shorted.

   d. Resistors short, open, or change in value.

   e. Capacitors open, short, or leak.

6. Make exact transistor replacements, if possible.

7. Replace precision resistors and Zener diodes with identical components.

D. REPAIR AND REPLACEMENT

1. General

Determine the need for or replacement of parts by inspecting the recorder according to the preceding paragraphs. Replace any defective parts and resolder any loose leads or poor solder connections.

2. Replaceable Parts

Refer to Section 6 for a complete list of electrical parts. To ensure safe efficient operation, use only parts with the electrical characteristics and tolerances listed.

3. Circuit Board Repair

Exercise caution when removing or or replacing components from the recorder printed circuit board, especially when a component has multiple pins and each pin must be unsoldered individually. Too much heat applied to a small area may scorch the copper clad and loosen it from the board. To remove or replace circuit board components, use an iron of the Unger type with no more than a 30-watt tip and perform the following:

a. Dip the end of a braided shield or ground type strap in solder flux, and place the flux end of the strap over the point where solder is to be removed.

b. Place the iron on the strap, directly over the terminal. Capillary action draws the solder from the hole into the strap.

c. Humiseal areas of circuit board where components have been replaced.

4. Follow-up Potentiometer Replacement: After long periods of service the follow-up potentiometers may wear and become noisy. The replacement procedure (see Figure 5-2) for the potentiometer is outlined below:

a. Remove all signal and power connections from the recorder.

b. Mount the recorder in the maintenance stand, refer to Figure 5-1.

c. Manually position the pen trolley bracket to the lower right corner of the plotting surface. This rotates both follow-up potentiometers counter-clockwise.

d. Remove the bottom cover.

e. Loosen the two set screws on the potentiometer shaft coupling.

f. Pull the potentiometer until the shaft is free.

CAUTION

Cover the recorder with a cloth or other protective material to prevent solder from dropping into the recorder.

g. Unsolder all electrical connections noting the color coding.

h. Solder the electrical connections to the new potentiometer.

i. Slide the new potentiometer through the bracket. Seat the shaft in the coupling.

j. Ensure that the potentiometer alignment pin is positioned in its bracket hole. There should be a slight clearance (0.010-0.020) between potentiometer front and the rear face of the bracket.

k. Turn the potentiometer shaft full counter-clockwise then back off 5 or 10 degrees.

l. Ensure that the sheave is still in the full counter-clockwise position.

m. Tighten the two set screws on the coupling.

n. Manually move the carriage to the maximum extent of travel. If any binding or restriction of full travel occurs, loosen the set screws and check Steps k. and m. Ensure that full travel of the carriage is not limited by the stops within the potentiometer.

o. Recalibrate the recorder, Paragraph 5-5.

5. Cable Installation:

Two cables are used to move the pen slider bracket along the vertical axis; one cable is used to move the carriage along the horizontal axis. The cables should be routed according to the arrows and the alphabetical designations shown in Figures 5-3 for the Y axis, and Figure 5-4 for the horizontal X axis. All directions - clockwise, counter-clockwise, upper and lower - are given from the viewpoint of the accompanying illustrations. Prepare the recorder as follows:

a) Remove all signal and power connections.

b) Mount the recorder in the maintenance stand.

c) Remove the pen assembly.

d) Remove the bottom cover.

e) Remove the bezel by removing four hold-down screws.

f) Remove carriage cover by firmly pushing the cover toward front panel compressing hinge spring. Slide carriage cover off hinge pin.

g) Remove the six hold-down screws from the circuit board, rotate out to its restraining strap.

6. Y Axis Cables

a) See Figure 5-3. Rotate the Y sheave counter-clockwise to its stop.

b) Move the pen slider to the lower end of the carriage. Insert a holding pin (4-40 x 3/8 stud or screw will suffice) through hole R in the pen slider and hole A in the carriage. This prevents the pen slider from moving along the carriage while the cable is being strung.

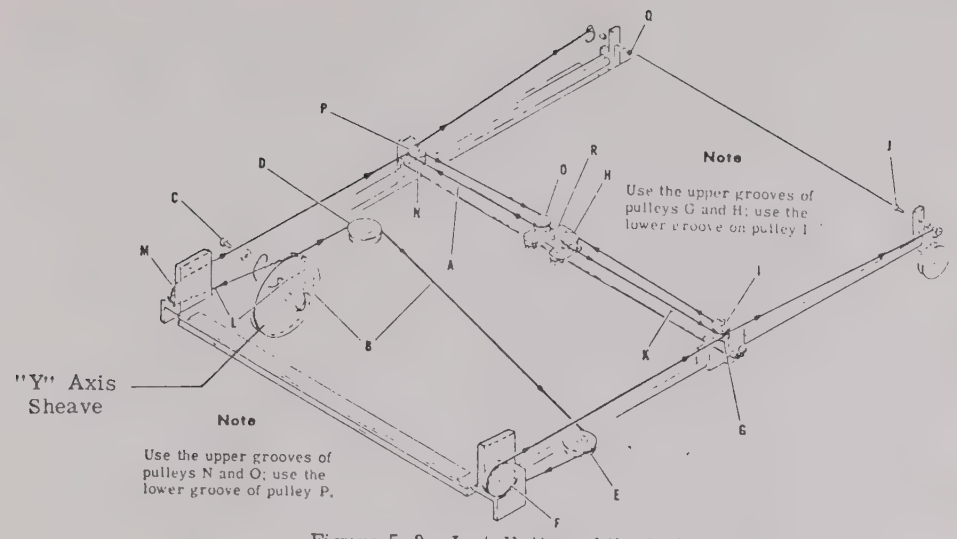


Figure 5-3. Installation of the Y Axis Cables

c) Thread the cable through hole B and secure under screw C.

d) Wrap the cable clockwise around the sheave to pulley D. Then string cable past pulleys E, F, G, H, I, and thread in hole in bracket insert.

e) Rotate the sheave counter-clockwise to its stop, winding the cable onto the sheave.

f) Secure the cable by tightening screw J at this point.

g) Insert the second cable into L and secure under the remaining sheave screw.

h) Wrap the cable counter-clockwise around the sheave to pulley M. Then string the cable past pulleys N, O, P, and secure under clamp Q.

i) Remove the holding pin from the pen slider.

j) Check the tension on both Y cables and adjust according to Paragraph 5-2. D.

7. X Axis Cable

a) See Figure 5-4. Turn the X sheave counter-clockwise to its stop.

b) Insert the cable end through hole A and secure under screw B.

c) Wrap the cable clockwise around the sheave to pulley C. Then string the cable past pulleys C, D, E, F (tension pulley), G, H, I, J, and K. Tape the cable to the table bottom to maintain tension.

d) While maintaining tension on the cable, rotate the X sheave clockwise (winding cable onto the sheave) to its stop.

e) Use tape to hold the sheave in place. Wrap the cable counter-clockwise around the sheave, through hole L and secure the cable end under the remaining screw. Remove tape from the sheave and from the table bottom.

f) Rotate the sheave counter-clockwise to its stop and move the carriage to the left end of the table. Use screws N and M to clamp cable under both ends of the carriage; the carriage must be clamped perpendicular to the cable.

g) Check the tension on the horizontal axis cable and adjust according to Paragraph 5-2. D. 1.

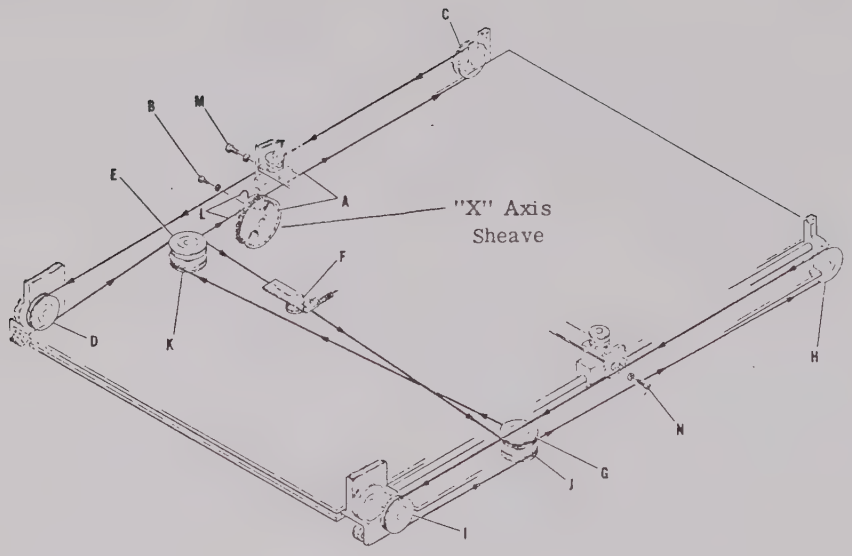


Figure 5-4. Installation of X Axis Cable

E. VACUUM SYSTEM

When the recorder is operational, the vacuum system holds the graph paper firmly in place on the plotting surface. Failure to obtain an adequate holding force could be caused by misalignment of the graph paper, restricted vacuum holes, or misalignment of the vacuum fan. Failure to obtain any holding force is caused by an inoperative vacuum motor.

1. Insert and align graph paper according to instructions in paragraph 3-3. C.

2. Ensure that the vacuum holes on the plotting surface are open (free from dust, bits of paper, etc).

3. If necessary, realign the vacuum fan by loosening the appropriate screws. Either move the motor with respect to the recorder frame, or reposition the vacuum fan along the motor drive shaft.

4. If the vacuum motor is inoperative, check for an open power lead to the motor or an open winding in the motor.

(Intentionally blank.)

5-4. PERFORMANCE CHECKS

A. MECHANICAL

If an electrical malfunction is encountered during the mechanical checks, locate and repair the malfunction before proceeding. Refer to paragraph 5-3. In some cases, a review of the electrical checks might be helpful in pinpointing malfunctions discovered during the mechanical checks.

Note

Perform steps 1, 2, and 3 with the pen removed.

1. Friction

Loosen the clutch on each axis. Set the POWER switch to OFF. and check the movement of the carriage and pen trolley in both directions. If the force required to move the carriage exceeds 4.5 ounces (125 grams) or the force required to move the pen exceeds 3.5 ounces (100 grams), refer to paragraph 5-2, D, 1. Tighten the clutches per paragraph 5-4, A, 5.

2. Paper Holddown Force

Note

All panel controls do not appear on some options. Perform the actions required externally when a specific panel control is not available.

Align a sheet of 11 x 16-1/2 in. (28 x 42 cm) graph paper on the plotting surface. Set the POWER switch to ON, PEN switch to UP, and PAPER switch to LOAD. Check the force required to move the paper in a plane parallel to the plotting surface. This force should be at least 7 ounces (200 grams) for 11 x 16-1/2 in. (28 x 42 cm) graph paper and 2.5 ounces (70 grams) for 8-1/2 x 11 in. (21.6 x 28 cm) graph paper at 60 Hz.

3. Pen Lift Operation

Use a new sheet of graph paper 11 x 16-1/2 in. (28 x 42 cm) to check the pen lift operation.

a. Set the POWER switch to ON, the PAPER switch to RECORD, and the PEN switch to UP. Use the ZERO control to move the pen around the periphery and across the center of the graph paper. The pen tip must clear the paper by 0.030 in. (0.075 cm) at all points.

b. Check the pen down position. Set the PEN switch to DOWN, and move the pen around the periphery and across the center of the graph paper. Make certain that the pen writes everywhere. There should be a 0.010 to 0.020 in. (0.025 to 0.050 cm) clearance between the pen lift roller bearing and the pen lift bar.

c. Check the pen lift action. The pen lift bar and the pen must snap up when the PEN switch is changed from DOWN to UP. The pen lift bar and the pen must snap down when the PEN switch is changed from UP to DOWN.

4. Pen Spring Tension

With the PEN switch set to DOWN, check the force holding the pen on the graph paper. This force should be between 1/4 to 1/2 ounce (8 to 12 grams).

5. Clutch Adjustment

Set the POWER switch to ON, the PAPER switch to RECORD, and the PEN switch DOWN. Adjust the HORIZONTAL axis clutch so that the clutch slips when the carriage is moved between 0.1 and 0.2 in. (0.25 and 0.5 cm). Perform the clutch adjustment on the VERTICAL axis.

6. Paper Alignment

Ensure that the graph paper is properly aligned on the plotting surface (paragraph 3-3, C). Set the POWER switch to ON, the PAPER switch to RECORD, and the PEN switch to DOWN. Use the HORIZONTAL ZERO control to draw a straight horizontal line. Use the VERTICAL ZERO control to draw a straight vertical line. If this line is not parallel to the vertical lines on the graph paper, the carriage may not be properly attached (perpendicular) to the horizontal cable.

7. Recording Area

Set the POWER switch to ON, the PAPER switch to RECORD, and the PEN switch to DOWN. Use the ZERO control to check that the pen writes beyond all four graph margins. If the pen fails to write beyond the left and right margins, the HORIZONTAL axis cable may not be installed properly. If the pen fails to write beyond the top and bottom margins, the VERTICAL axis cables may not be installed properly.

Note

Ensure that pen or carriage travel is not limited by the mechanical stops in the followup potentiometer. Refer to paragraph 5-3, D, 4.

8. Paper Load

Set the POWER switch to ON, the PAPER switch to RECORD, and the PEN switch to UP. Use the HORIZONTAL axis ZERO control to zero the carriage to the left margin of the recording area. Set the PAPER switch to LOAD. The carriage should slowly move to the right stops in approximately two seconds. Return the PAPER switch to RECORD. The carriage should return to the original zero point at slewing speed.

B. ELECTRICAL PERFORMANCE CHECKS

Performance should be checked with differential and single-ended input connections (see Figure 2-3 and 2-4). Align a sheet of 11 x 16-1/2 inches (28 x 42 cm) graph paper on the plotting surface (see paragraph 3-3, C). Perform the following checks and adjustments:

1. Retrace Hysteresis

Set the SENSITIVITY switches to 100 mV/in. (50 mV/cm), INPUT switches to CALIB, POWER switch to ON, PAPER switch to RECORD and PEN switch to DOWN. Adjust the voltage source for a linear (triangular) output equal to 2 inches/second (5 cm/second) writing speed, and connect the signal to both recorder input terminals. Draw a trace and retrace with a 1 to 1 slope. The maximum allowable deviation between trace and retrace is 0.030 inch (0.075 cm). Establish a 10 to 1 slope by setting the HORIZONTAL SENSITIVITY switch to 1 V/in. (0.5 V/cm). Draw a trace and retrace, the deviation should not exceed 0.030 inch (0.075 cm). Return the switch to the 100 mV/in. (50 mV/cm) position, and establish a 1 to 10 slope by setting the VERTICAL SENSITIVITY switch to 1 V/in. (0.5 V/cm). The trace-retrace deviation should not exceed 0.020 inch (0.050 cm).

2. Overshoot

Set the HORIZONTAL SENSITIVITY control to 1 V/in. (0.5 V/cm) and the INPUT control to CALIB. Connect a dc source through an ON-OFF switch (SPDT with OFF side connected to LOW, see Figure 5-6) to the HORIZONTAL input terminals. Set the ON-OFF switch to OFF and adjust the dc source for an output of approximately 6 volts. Set the ON-OFF switch to ON, the pen should plot a horizontal line approximately 6 inches (12 cm) long, overshoot, and then return to the 6 inches (12 cm) point. Set the ON-OFF switch to OFF (use the ZERO control on the VERTICAL axis to prevent overlapping). Repeat this procedure one or two times, then observe the overshoot. The overshoot should not exceed 0.30 inch (0.75 cm).

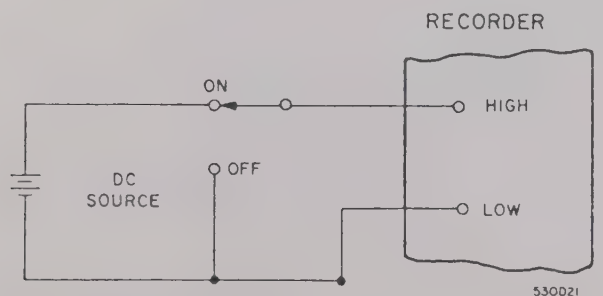


Figure 5-6. Setup for Overshoot Check

Perform an overshoot check on the VERTICAL axis. The overshoot should not exceed 0.20 inch (0.50 cm).

3. Frequency Response

Set the HORIZONTAL SENSITIVITY switch to 1 V/in. (0.5 V/cm) and the INPUT switch to CALIB. Adjust the function generator for an output of 1 volt peak-to-peak at 1 Hz, and apply the signal to the HORIZONTAL input terminals. Set the VERTICAL axis to SWEEP on the INPUT switch and RATE IN./SEC or RATE CM/SEC to 0.2 (0.1). Set the POWER switch to ON and the PAPER switch to RECORD. Press the PEN switch to DOWN and the SWEEP switch to START simultaneously. Initially the horizontal deflection is 1 inch (2 cm). Slowly increase the generator frequency to 5 Hz (maintaining the amplitude constant). At 5 Hz the horizontal deflection should be at least 0.7 inch (1.4 cm). Perform the same frequency response check on the VERTICAL axis.

NOTE

On Models 530 and 530M use zero controls or external signals as sweep function.

4. Variable Sensitivity

Set the SENSITIVITY switches to 1 V/in. (0.5 V/cm), the INPUT switches to CALIB, the POWER switch to ON, the PAPER switch to RECORD, and the PEN switch to DOWN. Establish a zero point. Apply 2 volts dc to both HORIZONTAL and VERTICAL input terminals. The deflection should be two inches (four cm) in each axis. Set the PEN switch to UP. Move the INPUT switches to VAR, and turn the VARIABLE controls fully clockwise. Set the PEN switch to DOWN. The deflection in each axis should be at least two inches (four cm). Turn the VARIABLE controls fully counterclockwise. The deflection in each axis should be less than 0.2 inch (0.4 cm) referenced to the zero point.

5. Common Mode Rejection

At the HORIZONTAL input terminals; connect HIGH to GUARD, connect a 1 k resistor between HIGH and LOW, and connect a function generator between GND and HIGH (see Figure 5-7). Set the HORIZONTAL SENSITIVITY switches to 1 mV/in. (0.5 mV/cm) and the INPUT switch to CALIB. Set the VERTICAL axis to the SWEEP mode and establish a sweep rate of 0.2 in/sec (0.5 cm/sec). Adjust the generator for an output of 30 volts peak-to-peak at the line frequency ±2 Hz. The maximum horizontal deflection should be 0.10 inch (0.25 cm).

Remove the generator from the HORIZONTAL terminals and apply to the VERTICAL

input terminals. Perform the common mode rejection check on the VERTICAL axis.

NOTE

On Models 530 and 530M use zero controls or external signals as sweep function.

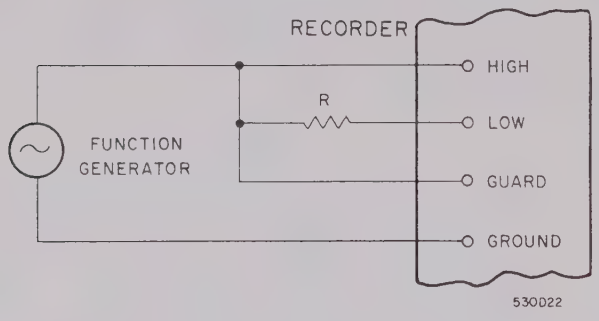


Figure 5-7. Setup for Common Mode Rejection Check

5-5. CALIBRATION PROCEDURE

Calibration of the recorder involves the adjustment of nine potentiometers for Models 530T and 530TM and eight potentiometers for Models 530 and 530M. The CAL (calibrate) potentiometers are adjusted to establish the proper full scale deflection for both axes, HORIZONTAL and VERTICAL. The sweep calibrate potentiometer (530T and 530TM) is adjusted to establish the proper rates in inches or centimeters per second. All calibration potentiometers are accessible when the bottom cover is removed. Potentiometer locations are shown in Figure 5-8.

A. PRELIMINARY CHECKS AND ADJUSTMENTS

1. Gain Potentiometer

Set the HORIZONTAL and VERTICAL INPUT switches to CALIB, the SENSITIVITY switches to 1 V/in. (0.5 V/cm), the POWER switch to ON, the PAPER switch to RECORD, and the PEN switch to DOWN. Check the HORIZONTAL static accuracy by manually moving the carriage off null and allowing the pen to slowly return to null. Do this for both the minus and the plus directions using the VERTICAL ZERO control to prevent overlapping. The deviation must be less than 0.030 inch (0.075 cm). If this value is exceeded, turn the HORIZONTAL gain control (R128) clockwise to a point where the accuracy meets the specification.

Repeat the same check on the VERTICAL axis by moving the pen off null. The deviation must not exceed 0.020 inch (0.050 cm).

2. Voltage and Current Offset

a. Set POWER switch to ON, LOAD switch to RECORD, and PEN switch to UP.

b. Set the HORIZONTAL INPUT switch to ZERO. Adjust the voltage offset potentiometer (R113) so that there is no deflection when switching the SENSITIVITY control between the 1 V/in. (0.5 V/cm) and 100 mV/in. (50 mV/cm).

c. Set the HORIZONTAL SENSITIVITY switch to 100 mV/in. (50 mV/cm). Adjust the current offset potentiometer (R110) so that there is no deflection when switching the INPUT control between the CALIB and ZERO positions.

d. Repeat steps b and c until any interaction ceases.

e. Repeat steps a through d on the VERTICAL axis using the VERTICAL controls.

B. RECORD MODE CALIBRATION (All Models)

Note

Preliminary adjustments must be performed before calibration.

1. Set the VERTICAL axis INPUT switch to ZERO; and set the HORIZONTAL axis INPUT switch to CALIB. and the SENSITIVITY switch to 100 mV/in. (50 mV/cm).

2. Set the POWER switch to ON, PAPER switch to RECORD, and PEN switch to DOWN. Establish a zero reference point. Apply 1.5 ±0.001 Vdc to the HORIZONTAL input terminals.

Note

If operating with an Ext. Ref. option, calibrate with accurate reference voltage applied.

3. Adjust the HORIZONTAL calibration potentiometer (R135, Figure 5-8) for exactly 15 inches (30 cm) deflection.

4. Repeat steps 2 and 3, until adjustment of the potentiometer produces negligible shift in the zero point.

5. Reduce the voltage in 0.1 volt steps to give 1 inch (2 cm) steps on the graph paper. Using the VERTICAL ZERO control, determine that each step is within ±0.015 inch (±0.038 cm).

6. Check the deflection sensitivity on all the other HORIZONTAL ranges.

7. Set the HORIZONTAL axis INPUT switch to ZERO; and set the VERTICAL axis INPUT switch to CALIB. and the SENSITIVITY switch to 100 mV·in. (50 mV·cm).

8. Establish a zero reference point. Apply 1 ±0.001 Vdc to the VERTICAL input terminals.

9. Adjust the VERTICAL calibration potentiometer (R235), see Figure 5-8, for exactly 10 inches (20 cm) deflection.

10. Repeat steps 8 and 9 until adjustment of the potentiometer produces negligible shifts in the zero point.

11. Reduce the voltage in 0.1 volt steps to give 1 inch (2 cm) steps on the graph paper. Using the HORIZONTAL ZERO control, determine that each step is within ±0.010 inch (±0.025 cm).

12. Check the deflection sensitivity on all the other VERTICAL ranges.

C. SWEEP MODE CALIBRATION PROCEDURE (Models 530T and 530TM)

Note

Each axis must be calibrated according to paragraph 5-5, A. before calibration of the sweep circuit.

1. Set the HORIZONTAL INPUT switch to SWEEP, the PAPER switch to RECORD, the PEN switch to UP, the POWER switch to ON, and the RATE IN/SEC (CM/SEC) switch to 0.5 or 1.

2. Using the HORIZONTAL ZERO control, position the pen to the left edge of the graph paper.

3. Apply a signal with a known time interval to the VERTICAL input terminals.

4. Push the SWEEP switch to START and the PEN switch to DOWN simultaneously.

5. After at least 10 inches (25 cm) of travel, return the SWEEP switch to RESET and the PEN switch to UP simultaneously.

6. Observe the sweep rate, then adjust the sweep calibrate potentiometer (R3, Figure 5-8) to bring the rate accuracy within ±1% of full scale.

7. Check all the other sweep rates for ±1% calibration.

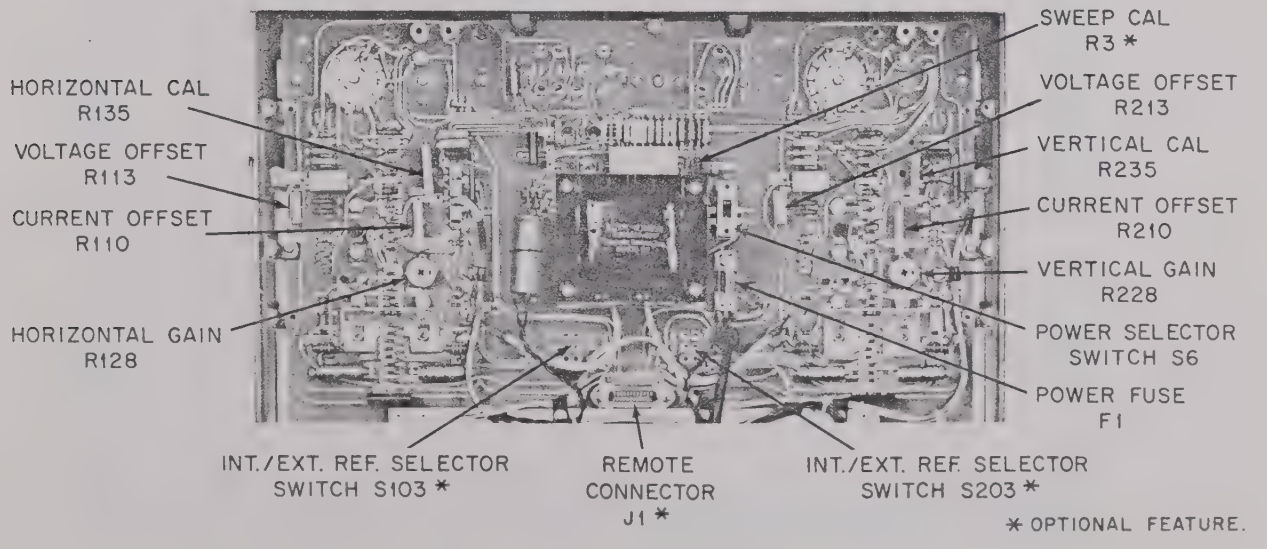


Figure 5-8. Calibration Adjustment Locations

ESTERLINE ANGUS INSTRUMENTATION SERVICES

TECHNICAL ASSISTANCE

Knowledgeable teams of Esterline Angus Application Engineers, Sales Engineers, and Service Engineers are always available for consultation regarding your equipment needs. When writing a Sales Office for technical assistance, be sure to include a complete description of your specific problem and both model and serial numbers of each instrument involved. Address all correspondence to your nearest Esterline Angus Sales Office (see office listing or consult local directory).

FIELD SERVICE

Esterline Angus affords the instrument purchaser an outstanding network of factory-trained Service Engineers. These individuals are highly qualified to maintain, repair, or modify instrumentation at any field installation. Contact your nearest Esterline Angus Sales Office for prompt field service (see office listing or consult local directory). Periodic Service Agreements are also available for instrument purchasers by contacting the Esterline Angus factory. Address all requests to: Service Manager, Esterline Angus Instrument Corp., Box 24000, Indianapolis, Indiana 46224.

ORDERING PARTS

When spare or replacement parts are required for an instrument, contact your nearest Esterline Angus Sales Office (see office listing or consult local directory). Furnish this authorized representative with a complete description of the part, its part number, and both model and serial numbers of the associated instrument. If all information is correctly supplied, Esterline Angus will be able to fill parts orders promptly.

RETURNING INSTRUMENTS

Should it become necessary to return an instrument to the factory, forward a purchase order or letter of explanation to: Esterline Angus Instrument Corp., Box 24000, Indianapolis, Indiana 46224. Follow instrument shutdown procedures given in the instruction manual. Pack the unit safely, mark "HANDLE WITH CARE", fully insure, and ship prepaid to: Esterline Angus Instrument Corp., 1201 Main Street, Speedway, Indiana 46224. Make sure that you include your name and return address.

WARRANTY—Only the products manufactured by the Seller and sold hereunder are warranted as free from defects of materials and workmanship and in conformance with specifications. There are no other oral, statutory, or implied warranties. Seller's obligation hereunder shall be and is limited to servicing or replacing f.o.b. its plant in Indianapolis, Indiana or such other point as Seller may designate, or refunding the purchase price of any such product manufactured by the Seller which proves to be defective in material or workmanship or which fails to conform to specifications therefor, provided that (1) written notice of such defect or failure is received by Seller from Purchaser within one year after the date of shipment of such products manufactured by the Seller, and (2) such defects, in the opinion of Seller, shall not have arisen from improper use. The absence of such written notice of defect, or failure, or lack of conformance to specifications within the specified time shall constitute a waiver of any claim. Seller may, after receipt of notice, require purchaser to send said products, transportation prepaid, to Seller for its examination and inspection.

SECTION 6- ILLUSTRATED PARTS BREAKDOWN

6.1 INTRODUCTION

This section of the instruction manual includes complete listings of all replaceable parts for Model 530 X-Y recorders. Each parts list table covers a major assembly or group of related components used in the construction of the instrument (see Index below). Illustrations accompany each parts list to assist the user in obtaining a replacement part number (refer to para. 6.3). When options or special features are supplied, refer to the separate supplements and/or drawings furnished with this manual.

6.2 PARTS TABLES

6.2.1 ITEM NUMBER COLUMN

The first two columns in each parts table contains identifying numbers for assemblies, subassemblies, or parts that are pointed out in the accompanying parts location illustration. These numbers are listed in numerical order for quick reference; however, since the same numbers may be used in more than one illustration, refer to only the Figure listed in the heading of each Figure number column.

6.2.2 PART NUMBER COLUMN

a. Esterline Angus part numbers for all replaceable items appear in the Part Number column of each parts table. If a number is omitted from this column, the part is an optional component selectable when ordering the recorder. Replacement part numbers for such selectable items will be found on the instrument Data Sheet--furnished with this manual.

b. Additional informative coding may be found in the Part Number column when necessary (see table footnotes).

6.2.3 DESCRIPTION COLUMN

All parts are identified by either an electrical or mechanical nomenclature in the Description column of each parts table. This column employs an indention system so that the user can determine the precise parts included in each assembly. Any assembly that is comprised of field replaceable parts will have these parts indented directly below the assembly listing.

6.2.4 QUANTITY COLUMN

The number represented in the Qty. Column of each parts table refers to the quantity used in the assembly covered under the title of each particular list. This quantity, therefore, does not necessarily reflect the total number used in the entire instrument. More than one Qty. column will exist when differences between major assembly options cause variation in the number of parts required. The term "A/R" in a quantity column listing is an abbreviation for As Required. This term is used generally on optional parts.

6.3 LOCATING A PART NUMBER

To find a specific part number in this section of the manual, first determine the major assembly table in which the part would be found by referring to the index below; then, visually locate the part on the accompanying illustration for that table. Since each part is pointed out by an arrow and an item number, simply search down the Fig. Item No. column in the table until the corresponding item number is located. Opposite this item number, in other columns of the table, you will find the part number and all of the descriptive information necessary for ordering the part.

6.4 ORDERING INFORMATION

All parts and recording supplies are available through Esterline Angus Sales Offices. To insure prompt delivery and receipt of parts that are compatible with your specific instrument, always mention the recorder Model Number and Serial Number--as well as the part number and description of all items requested.

6.5 MODEL CODES

This parts list covers the following models:

Model 530	A
Model 530T	B
Model 530M	C
Model 530TM	D
Computer reference option	E
Retransmitting potentiometer option	F

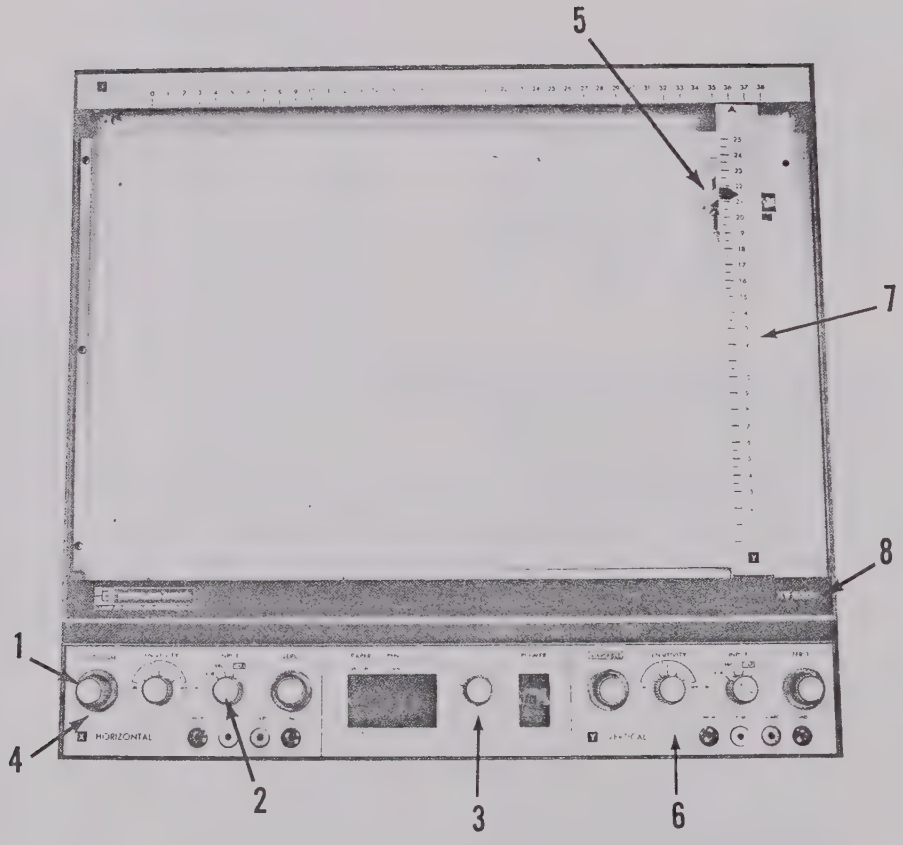


Figure 6-1. Model 530 Series X-Y Recorders

Fig.	Index No.	Description	Part Number	Qty.	Code
		SHIPPING ASSEMBLY X-Y Recorder, Model 530	38421004-001		A
		SHIPPING ASSEMBLY X-Y Recorder, Model 530T	38421004-002		B
		SHIPPING ASSEMBLY X-Y Recorder, Model 530M	38421004-003		C
		SHIPPING ASSEMBLY X-Y Recorder, Model 530TM	38421004-004		D
		. X-Y Recorder, Model 530	38421005-101		A
		. X-Y Recorder, Model 530T	38421005-102		B
		. X-Y Recorder, Model 530M	38421005-103		C
		. X-Y Recorder, Model 530TM	38421005-104		D
		. Computer Reference	38421005-005		E
		. Retransmitting Potentiometer	38421005-007		F
		. Paper, Graph (English)	16800046-001	1 box	*
		. Paper, Graph (Metric)	16800593-001	1 box	*
		. Accessory Kit Assembly	16760509-001	1	
		. . Box, Accessory	16775153-001	1	
		. . Marker, Nylon Red (6 Pack)	16774972-111	1	
		. . Kit, tool	16771495-001	1	
		. . . Wrench, Allen, 0.050	16769256-105	1	
		. . . Wrench, Allen, 1/16	16769256-107	1	
		. . . Wrench, Allen, 5/64	16769256-109	1	
		. . Connector, Mating	16750110-013	1	*
		. . Cover, Dust	16800521-001	1	*
		. Manual, Technical	38421008-001	1	
		. Marker, Nylon Green (6 Pack)	16774972-112	1	
		. Accessory Rack Kit (See Fig 6-2 for breakdown)	16805024-001	1	*
		Case, Carrying (Option)	S-21984		*
6-1	1	. . Knob, Control	16757252-611	4	A,B
	2	. . Knob, Control	16757252-411	4	C,D
	3	. . Knob, Control	16757252-411	1	
	4	. . Knob, Lock	16738444-101	4	
	5	. . Pen Bracket Assembly	16774970-001	1	
	6	. . Panel, Front	16805062-002	1	A
		. . Panel, Front	16805065-002	1	B
		. . Panel, Front	38421016-002	1	C
		. . Panel, Front	38421015-002	1	D
	7	. . Decal, Carriage Cover	16805249-001	1	
		. . Decal, Carriage Cover	16805286-001	1	
6-1	8	. . Bezel Assembly (See Fig 6-6 for breakdown)	38421021	1	

* Optional

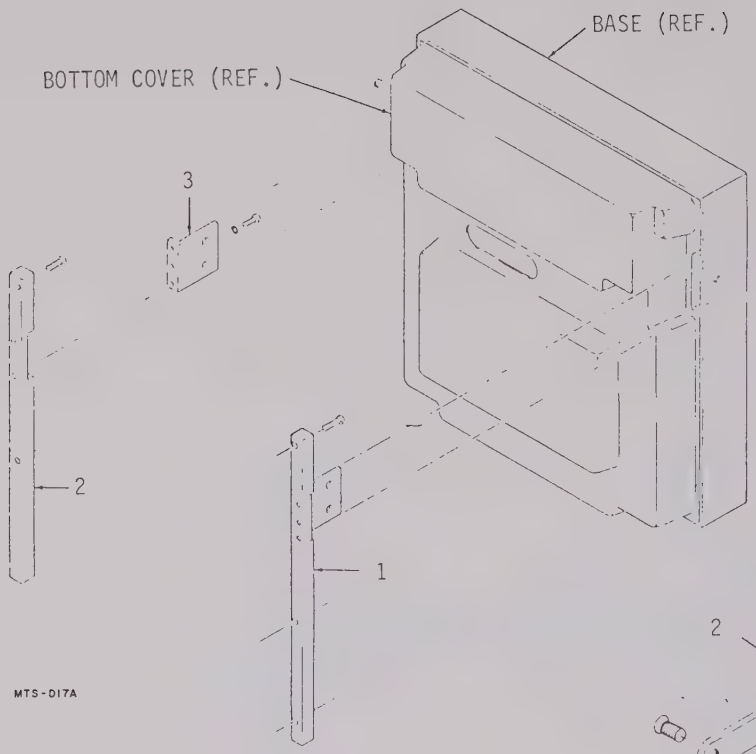


Figure 6-2. Rack Mount

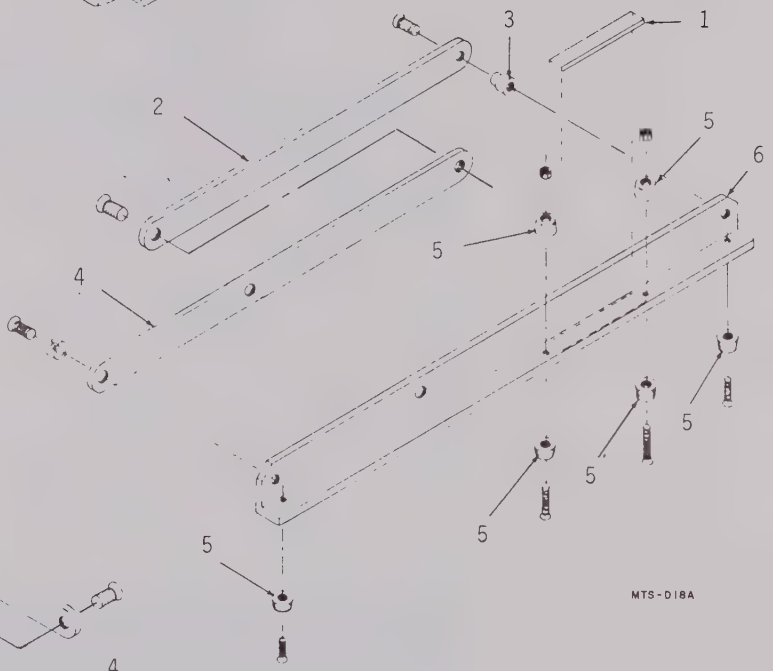


Figure 6-3. Service Stand Assembly (Right hand)

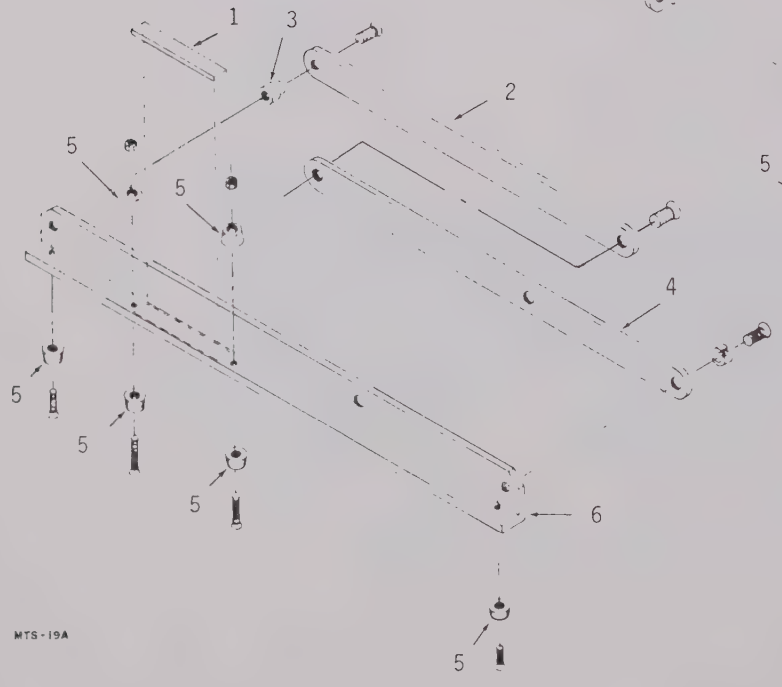
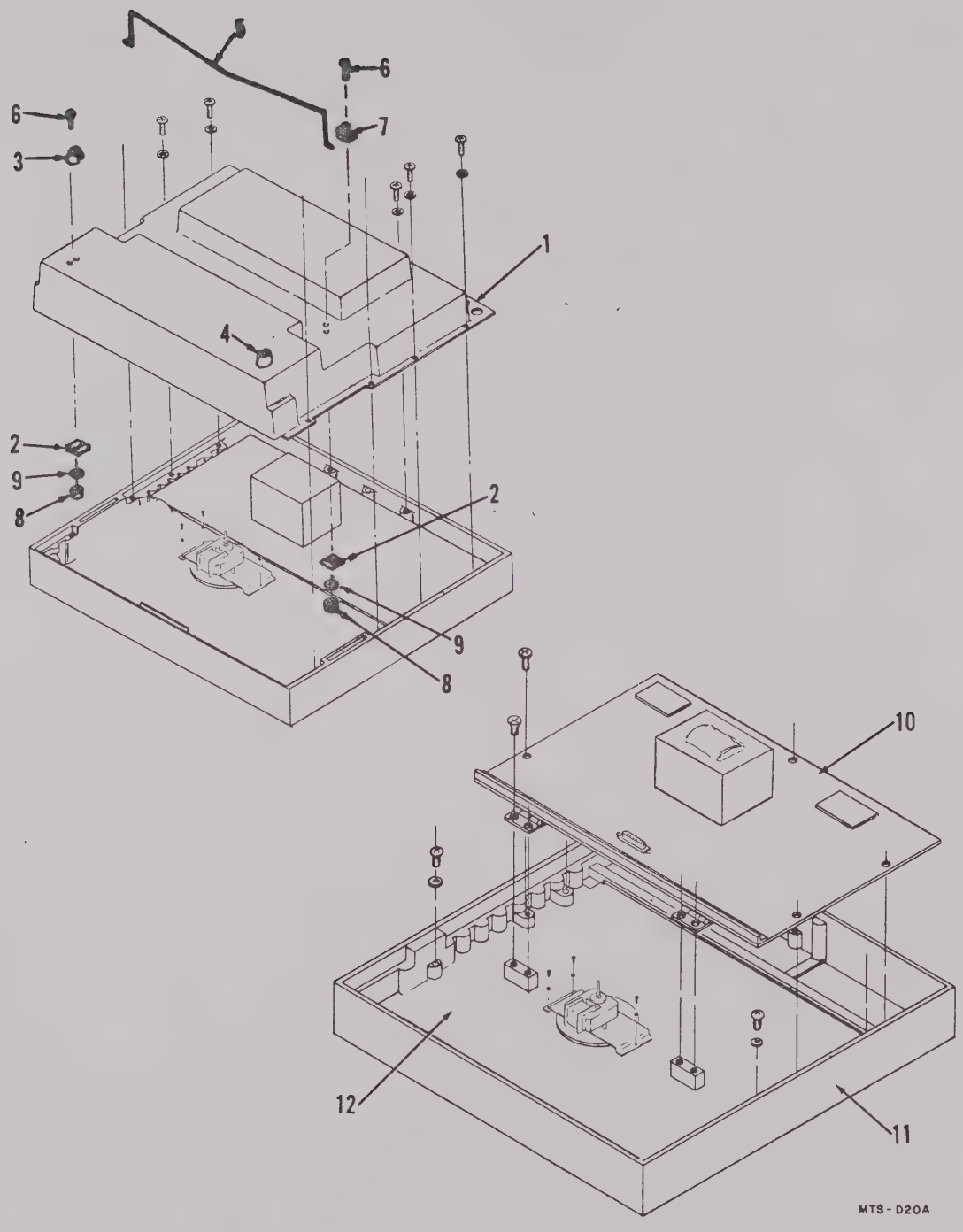


Figure 6-4. Service Stand Assembly (Left hand)

FIG. NO.	ITEM NO.	DESCRIPTION	PART NO.	QTY.
6-2		. RACK MOUNT ACCESSORY KIT	16805024-001	1
	1	. . Rack Mount Bar, right hand	16805114-001	1
	2	. . Rack Mount Bar, left hand	16805115-001	1
	3	. . Rack Mount Bar	16805116-001	2
6-2		. Bottom Cover (ref) See Fig. 6-5		
6-3		. SERVICE STAND ASSY, RIGHT HAND ACCESSORY	16805046-001	1
	1	. . Scotch Foam, 1/8 x 2 x 1/4"	16750361-404	1
	2	. . Short Leg	16805110-001	1
	3	. . Standoff	16759850-221	1
	4	. . Long Leg	16805112-001	1
	5	. . Rubber Foot	16800186-001	6
6-3	6	. . Base right hand	16805111-001	1
6-4		. SERVICE STAND ASSY, LEFT HAND ACCESSORY	16805047-001	1
	1	. . Scotch Foam, 1/8 x 2 x 1/4"	16750361-404	1
	2	. . Short Leg	16805110-001	1
	3	. . Standoff	16759850-221	1
	4	. . Long Leg	16805112-001	1
	5	. . Rubber Foot	16800186-001	6
6-4	6	. . Base, left hand	16805113-001	1



6-5. MTS Model 431.12 Bottom View

Fig.	Index No.	Description	Part Number	Qty.	Code
6-5		RECORDER BOTTOM VIEW			
		. BOTTOM COVER			
	1	With Bail and Cord Holder Options	16805028-101		*
		With Bail Option Only	16805028-102		*
		With Cord Holder Option Only	16805028-103		*
		Without Bail or Cord Holder Options	16805028-104		
	2	. . Plate, Support	16805061-002	4	
	3	. . Bumper, Buckeye Stand	16800695-001	1	
	4	. . Bumper, Buckeye Stand	16800695-002	1	
	5	. . Bail, Tilt, Buckeye	16766884-001	1	
	6	. . Screw, Pan HD 6-32	16765278-236	A/R	
	7	. . Holder, Power Cord	16771767-001	2	
	8	. . Nut, Plain Hex No. 6-32	16755689-007	8	
	9	. . Washer, Lock Int. Tooth	16750431-005	8	
	10	. MAIN CIRCUIT-BOARD ASSY (See Fig. 6-16 for breakdown)	16771695	1	
	11	. BASE	16771158-001	1	
6-5	12	. MAIN TABLE ASSY	16774309-001	1	

* Option.

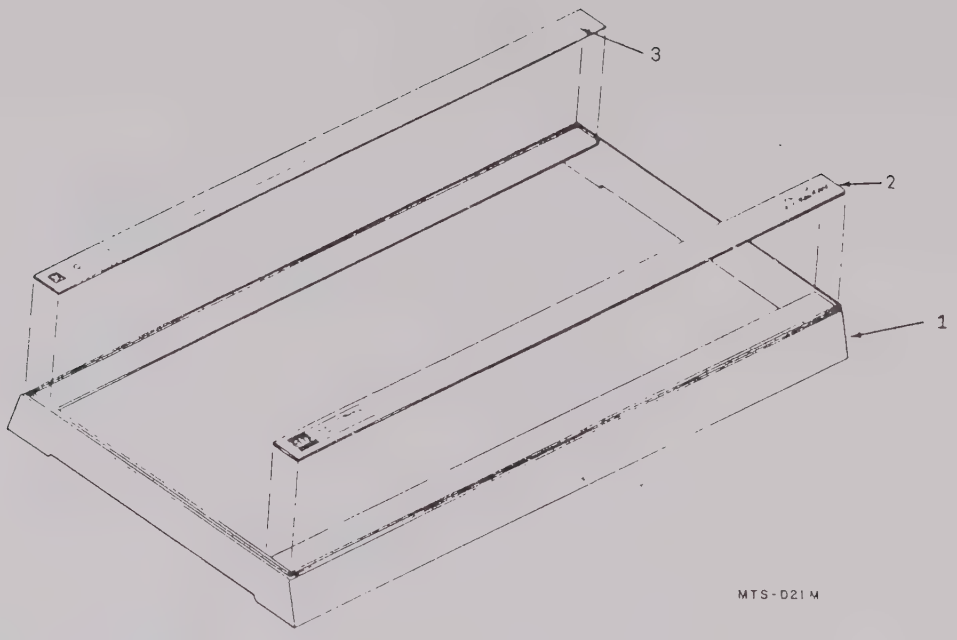


Figure 6-6 Bezel Assembly

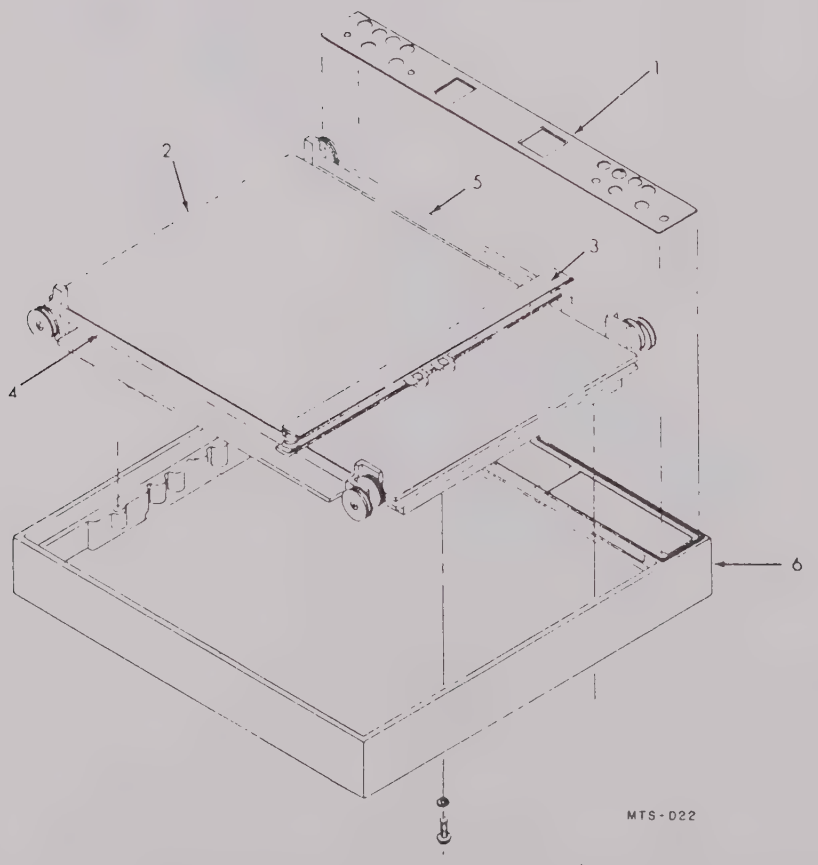


Figure 6-7. Main Table Assembly

Fig.	Index No.	Description	Part Number	Qty.	Code
6-6	1	BEZEL ASSEMBLY	38421021-001	REF	A,B
		BEZEL ASSEMBLY	38421021-002	REF	C,D
		. Bezel	16774320-002	1	
	2	. Panel, Lower bezel	16805057-001	1	
	3	. Panel, Upper bezel	16805056-001	1	A,B
6-6		. Panel, Upper bezel	16805058-001	1	C,D
6-7	1	. Front Panel Plate (See Fig. 6-1 for breakdown)		1	
	2	. . MAIN TABLE ASSY (See Fig. 6-8 . . for breakdown)		1	
	3	. . CARRIAGE ASSY (See Fig. 6-10 for breakdown)		1	
	4	. . LOWER GUIDE ROD	16774130-001	1	
	5	. . PEN LIFT ROD ASSY (See Fig. 6-11 for breakdown)		1	
6-7	6	. . BASE (See Fig. 6-5 for breakdown)		1	

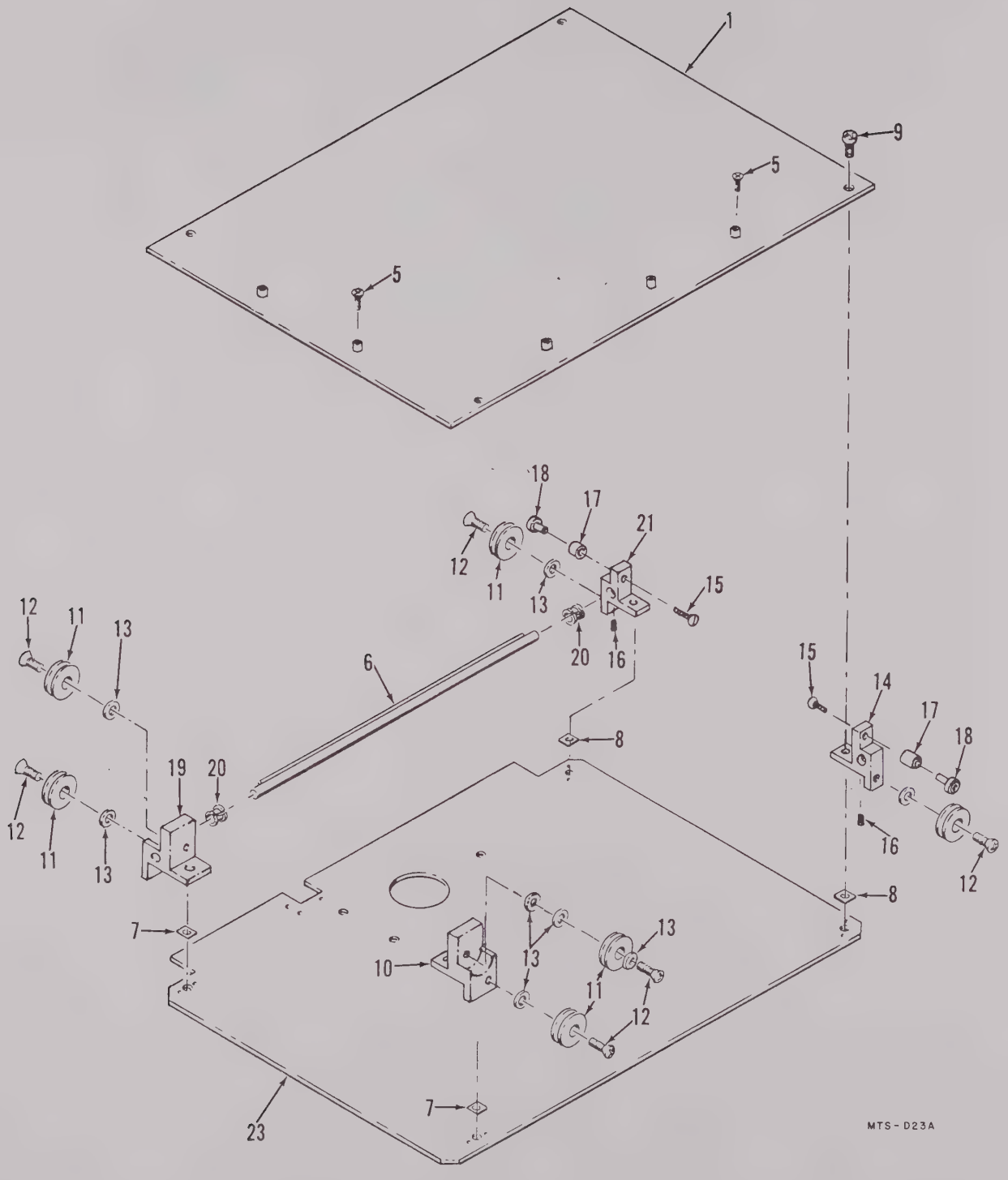


Figure 6-8. Main Table Assembly

FIG. NO.	ITEM NO.	DESCRIPTION	PART NO.	QTY.
6-8		MAIN TABLE ASSEMBLY	16774309-001	REF
		. MAIN TABLE SUBASSEMBLY	16774156-001	1
	1	. . Table, Main	16771498-002	1
	2	. . Post, Paper, Vertical	733A61	2
	3	. . Post, Paper, Horizontal	733A60	3
	4	. . Screw, Machine, pan HD	16765278-213	2
	5	. . Screw, Flat HD 4-40 x 3/16 Lg.	HX1444-3	3
	6	. PEN LIFT ROD ASSY (See Fig. 6-11 for breakdown)	16771142-001	1
	7	. SPACER, PLATE	16776426-002	2
	8	. SPACER, PLATE	16776426-001	2
		. CABLE, DRIVE, SST	16502175-001	A/R
	9	. SCREW, MACHINE, No. 6-32 x 1/2	16770893-026	4
		. PULLEY BRACKET ASSY Lower Left-hand	16774157-001	1
	10	. . Bracket Mounting	16774157-001	1
	11	. . Pulley Assy, 1.00 IN. Dia.	16757577-001	2
	12	. . Screw, Flat HD, 4-40 by 0.375 IN. Lg.	16750365-306	2
	13	. . Washer, Flat, CS, CAD plated 0.125 IN ID by 0.312 IN OD.	16755674-006	4
		. PULLEY BRACKET ASSEMBLY Lower Right-hand	16774158-002	1
	14	. . Bracket, Mounting	16774153-006	1
	11	. . Pulley Assembly, 1.00 IN. Dia.	16775577-001	1
	12	. . Screw, Flat HD 4-40 by 0.375	16750365-306	1
	13	. . Washer, Flat CS CAD plated 0.125 IN. ID by 0.312 IN OD	16755674-006	3
	15	. . Screw, Flat Hd, No. 4-40 x 3/8	16765280-225	1
	16	. . Setscrew, Hexagon DR, cup point, STL, No. 2-56 UNC3A by 0.250	16761013-003	1
	17	. . Spacer, Sleeve	16775958-001	
	18	. . Insert, Screw thread	16775957-001	
		. PULLEY BRACKET ASSEMBLY Upper Left-hand	16774159-001	1
	19	. . Bracket, Mounting	16774152-003	1
	11	. . Pulley Assembly, 1.00 IN. Dia.	16775577-001	2
	12	. . Screw, Flat HD, 4-40 by 0.375 IN. Lg.	16750365-306	2
	13	. . Washer, Flat CS CAD plated, 0.125 IN. ID by 0.312 IN. OD	16755674-006	3
	20	. . Bearing, Ball	16750791-012	1
		. PULLEY BRACKET ASSEMBLY Upper right-hand	16774160-002	1
	21	. . Bracket, Mounting	16774153-005	1
	11	. . Pulley Assembly, 1.00 IN. Dia.	16775577-001	1
	12	. . Screw, Flat HD, 4-40 by 0.375 IN. Lg.	16750365-306	1
	13	. . Washer, Flat CS CAD plated 0.125 IN. ID by 0.312 IN. OD	16755674-006	3
6-8	20	. . Bearing, Ball	16750791-012	1
	22	. SUB-TABLE ASSEMBLY (See Fig. 6-9 for breakdown)	16774179-001	1

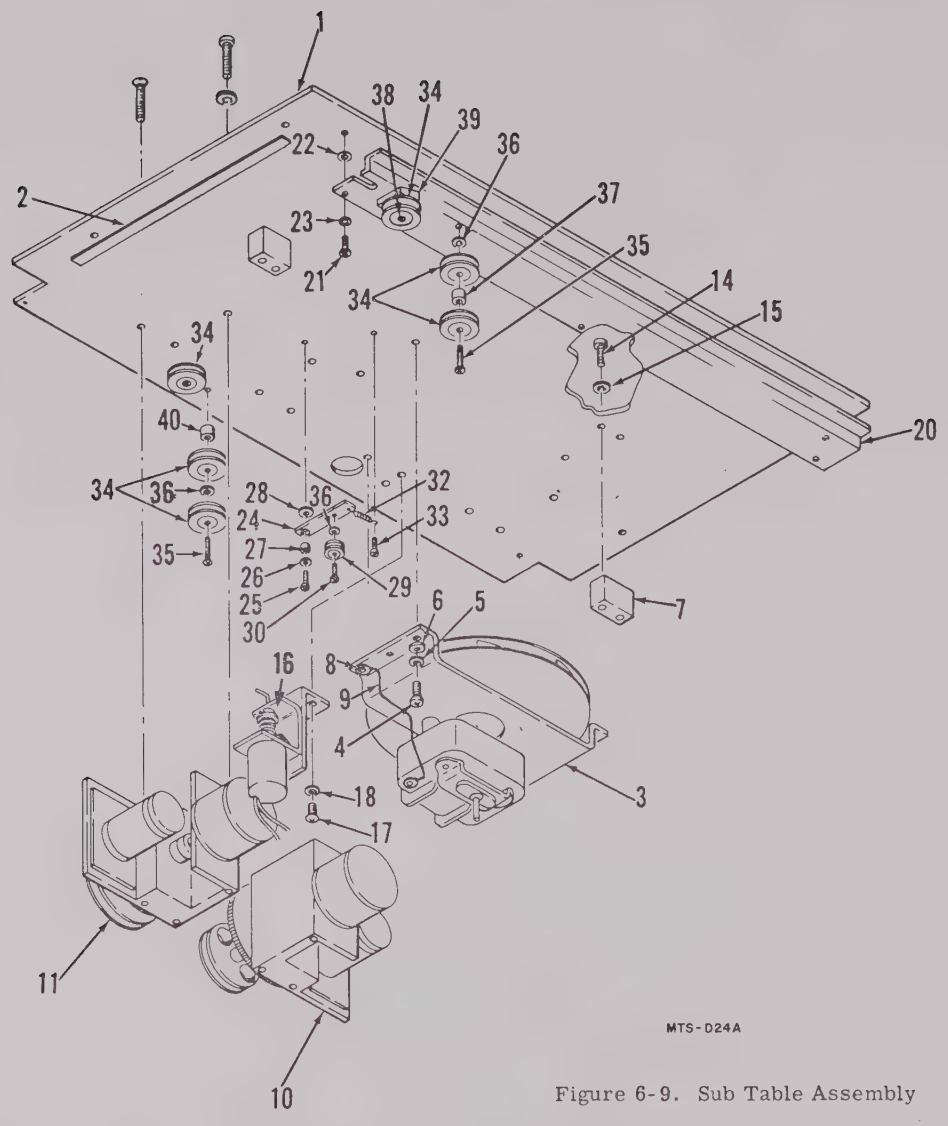


Figure 6-9. Sub Table Assembly

FIG. NO.	ITEM NO.	DESCRIPTION	PART NO.	QTY.
6-9		SUB-TABLE ASSEMBLY	16774179-003	REF
	1	. SUB-TABLE	16771148-003	1
	2	. TAPE, Foam, Gray	16501863-001	A/R
	3	. VACUUM FAN ASSY (see Fig. 6-13 for breakdown)	16774185-001	1
	4	. . SCREW, STL, No. 6-32 by0.4375 IN. Lg.	ND40213-43	3
	5	. . WASHER, No. 6, INT. TOOTH	SP1906	3
	6	. . WASHER, Flat, No. 6	NX1106	3
	7	. . SPACER	21596	3
	8	. . TERMINAL, Plasti-grip	8615-B	2
	9	. . WIRE, Tinned, AWG No. 16, Green	ND40042-078	4"
	10	. "X" SERVO ASSEMBLY (See Fig. 6-12 for breakdown)	16771133-003	1
6-9	11	. "Y" SERVO ASSEMBLY (See Fig. 6-12 for breakdown)	16771134-003	1

FIG. NO.	ITEM NO.	DESCRIPTION	PART NO.	QTY.
6-9	12	. BLOCK, Support	16771502-001	
	13	. . SCREW, F.H., 6-32 by 3/8 IN.	16765280-245	4
	14	. . SCREW, Machine, pan HD, phillips DR, CS CAD plated, No. 6-32 UNC2A by 0.375 IN. Lg.	16765278-235	6
	15	. . WASHER, Lock, INT tooth, SPG, STL plated, 0.150 In. Thk.	16750431-005	6
	16	. SOLENOID ASSEMBLY (See Fig. 6-14 for breakdown)	16775293-003	1
	17	. . SCREW, Machine, pan HD, phillips DR, CS CAD plated, No. 8-32 UNC2A by 0.312 IN. Lg.	16765278-264	2
	18	. . WASHER, Lock, INT tooth, SPG, STL CAD plated, 0.150 IN. Thk.	16750431-006	2
	19	. . WASHER, Flat, CS CAD plated, 0.174 IN. ID by 0.375 IN. OD by 0.032 IN. Thk.	16755674-010	2
	20	. SHIELD	16773327-002	1
	21	. . SCREW, Machine, pan HD, phillips DR, CS CAD plated, No. 4-40 UNC2A by 0.250 IN. Lg.	16765278-213	3
	22	. . WASHER, Flat, CS CAD plated, 0.125 IN. ID by 0.312 IN. OD by 0.032 IN. Thk.	16755674-006	6
	23	. . WASHER, Lock, INT tooth, SPG STL CAD plated, 0.150 IN. Thk.	16750431-003	3
	24	. BAR, Tension	16771504-001	1
	25	. . SCREW, Machine, pan HD, phillips DR, CS CAD plated, No. 4-40 UNC2A by 0.250 IN. Lg.	16765278-213	1
	26	. . WASHER, Flat, CS CAD plated, 0.125 IN. ID by 0.312 IN. OD by 0.032 IN. Thk	16755674-006	1
	27	. . SPACER, 1/8 IN.	16800258-002	1
	28	. . WASHER, Flat, No. 8	16755674-010	1
	29	. . PULLEY ASSEMBLY, Black, ½"	16775576-001	1
	30	. . SCREW, Flat HD, 4-40 by 5/16 IN. Lg.	16750365-305	1
	31	. . WASHER, Flat, No. 4	16726638-019	1
	32	. . SPRING, Extension	16771505-001	1
	33	. . SCREW, P.H., 2-56 by 3/16 IN.	16765278-202	1
	34	. PULLEY ASSEMBLY, Black, 1 IN.	16775577-001	6
	35	. . SCREW, Machine, Flat HD, phillips DR, 82 DEG, CS CAD plated, No. 4-40 UNC2A by 0.625 IN. Lg.	16765280-228	1
	36	. . WASHER, Flat, CS CAD plated, 0.125 IN. ID by 0.312 IN. OD by 0.032 IN. Thk	16755674-006	6
	37	. . NUT, Sleeve, self clinching, 6-32 UNC2B, 0.250 IN. OD by 0.266 IN. Lg.	16759850-221	1
	38	. . SCREW, Machine, Flat HD, phillips DR, 82 DEG, CS CAD plated, No. 4-40 by 0.500 IN. Lg.	16765280-227	3
	39	. . BLOCK, Spacer	16774133-001	1
6-8	40	. . NUT, Plain, Clinch, standard, BR NT plated, 3.250 IN. OD.	16769123-100	2

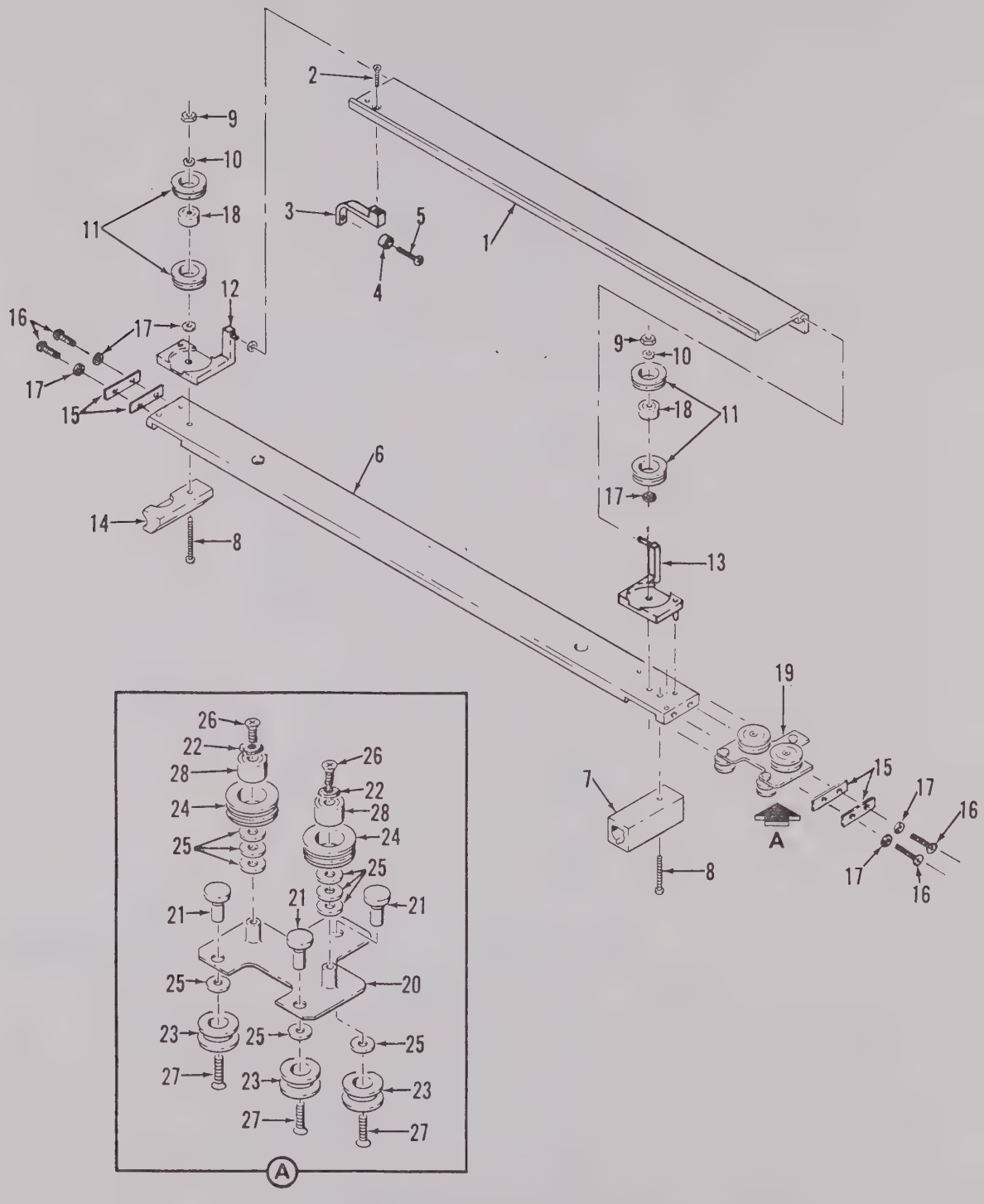


Figure 6-10. Carriage Assembly

FIG. NO.	ITEM NO.	DESCRIPTION	PART NO.	QTY.
6-10		CARRIAGE ASSEMBLY		REF
		. CARRIAGE COVER ASSY	16774187-001	1
	1	. . Cover, Pen Carriage	16805071-002	1
	2	. . . Screw, FLH, 2-56 x 3/16	16101228-001	1
	3	. . Bracket, Pen Lift	16774189-001	1
	4	. . . Bearing	16800248-001	1
	5	. . . Screw, Rd Hd 1-72 x 1/4	16750303-071	1
		. CARRIAGE ASSY	16774130-001	1
	6	. . Carriage, Pen	16771512-003	1
	7	. . Bearing, Sleeve-Lower	16771155-001	1
	8	. . . Screw, PNH, 4-40 x 3/4	16750367-312	2
	9	. . Nut, Hex 4-40	16103100-001	2
	10	. . Washer, Flat #4	16726638-019	A/R
	11	. Pulley Assy 1/2"	16775576-001	4
	12	. Bracket, Hinge-Upper	16774167-001	1
	13	. Bracket, Hinge-Lower	16774166-001	1
	14	. Bearing, Sleeve-Upper	16774167-001	1
	15	. Plate, Clamping-Drive Cable	16774117-001	4
	16	. . Screw, 6-32 x 1/4	16773015-203	4
	17	. . Washer, Flat #6	16750431-005	4
	18	. Spacer, Sleeve	16775958-003	2
	19			
	19	. SLIDER BRACKET ASSY	16805044-002	1
	20	. . Slider Mtg. Plate	16805108-002	1
	21	. . . Shoulder Stand-Off	16805109-001	3
	22	. . . Washer, Flat #2	16755674-002	2
	23	. . . "V" Bearings	16800246-001	3
	24	. . . Pulley 1/2" Black	16775576-001	2
	25	. . . Washer, Flat #4	16726638-019	A/R
	26	. . . Screw, FLT Hd 2-56 x 1/8	16761000-002	2
	27	. . . Screw, FLT Hd 2-56 x 1/4	16750365-104	3
6-10	28	. . . Spacer, Sleeve	16775958-002	2

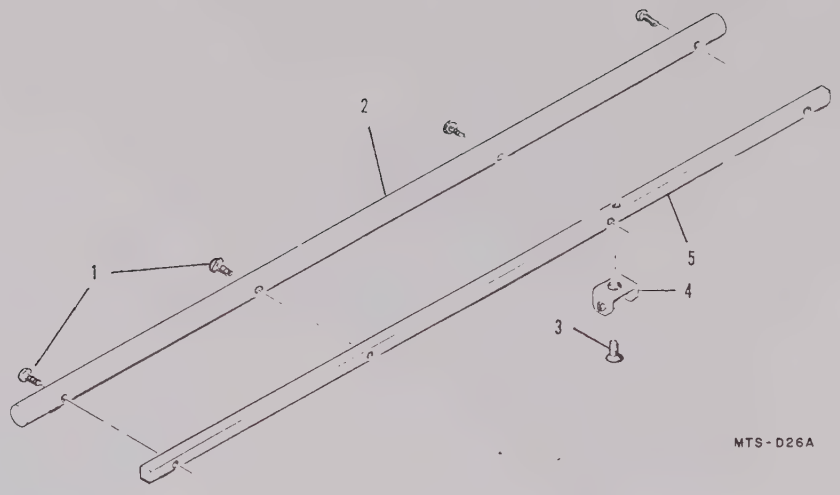


Figure 6-11. Pen Lift Rod Assy

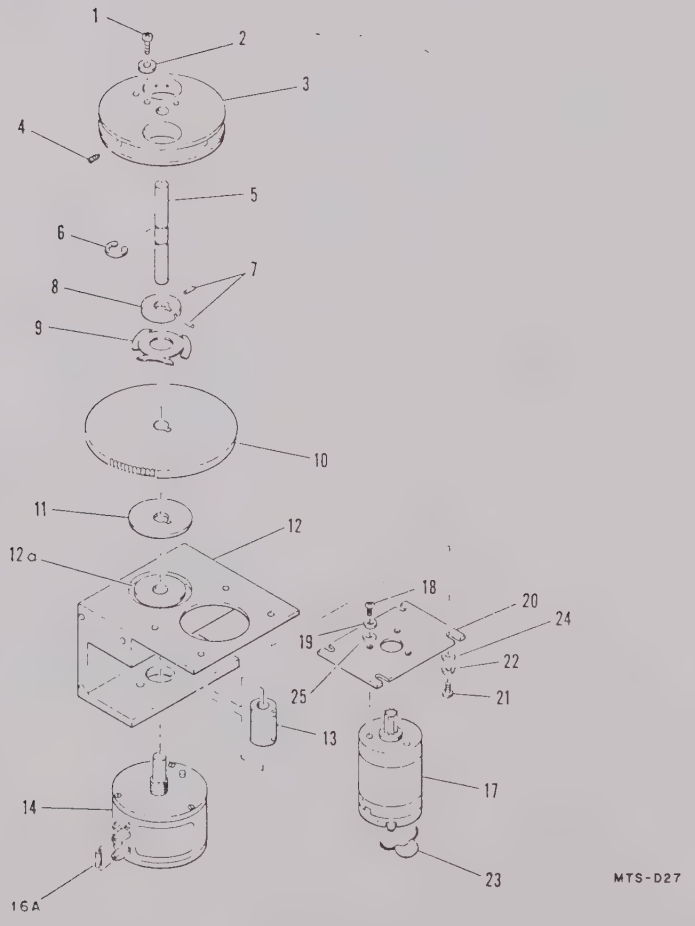


Figure 6-12. Drive Assembly

FIG. NO.	ITEM NO.		DESCRIPTION	PART NO.	QTY.
6-11			PEN LIFT ROD ASSEMBLY	16771142-001	REF
	1		. SCREW, R.H., 1-72 by 1/4 IN.	16750303-061	4
	2		. ROD, Upper Guide	16771509-001	1
	3		. SCREW, RD.H., 1-72 by 1/8 IN.	16750303-069	A/R
	4		. BRACKET, Pivot	16805099-002	1
6-11	5		. BAR, Pen Lift	16771510-001	1
6-12			DRIVE ASSEMBLY, Servo, X axis	16771133-003	1
			DRIVE ASSEMBLY, Servo, Y axis	16771134-003	1
	1		. Screw, P.H., 4-40 by 1/4 IN.	16765278-213	4
	2		. Washer, Flat, NO. 4	16755674-006	4
	3		. Sheave, X axis	16805277-001	1
			(ATTACHING PARTS)		
	4		. Screw, Set, 6-32 by 1/4 IN.	16761013-022	1
			. Sheave, Y and Y' axis	16805271-001	1
			(ATTACHING PARTS)		
			. Screw, Set, 6-32 by 1/4 IN.	16761013-022	2
			. Shaft Assembly, Servo	16774183-002	1
	5		. . Shaft	16771136-002	2
	6		. . Ring, Retaining, snap type	16800182-003	2
	7		. . Screw, Set, 2-56	16761013-003	5
	8		. . Clutch, Hub	38421011-001	4
	9		. . Washer, Bearing, spring	16800191-001	3
	10		. . Gear, Spur	16805088-002	2
	11		. . Washer, Flat, fiber	16771506-004	2
	12		. Bracket, Servo	16771132-002	2
	12A		. Bearing, Flange	16750791-009	4
	13		. Coupling, shaft	16755037-001	2
	14	R134	. Resistor, Variable, precision	16800064-002	2
		R234	5K, 0.1%		
			(ATTACHING PARTS)		
	15		. Nut (Part of It. 14)	No Number	1
	16		. Washer, Flat (Part of It. 14)	No Number	1
			. MOTOR ASSEMBLY, Servo	16775416-002	3
	17	B101,	. . Motor, Servo, DC, permanent	16800045-002	2
		B201	magnet		
			(ATTACHING PARTS)		
	18		. . Screw, P.H., 2-56 by 5/16 IN.	16765278-204	6
	19		. . Washer, Lock, NO. 2	16750431-001	6
	25		. . Washer, Flat, NO. 2	16755674-001	6
	20		. . Bracket, Isolation, motor	16771137-001	3
	21		. . Screw, P.H., 6-32 by 3/16 IN.	16758846-025	8
	22		. . Washer, Lock, NO. 6	16750431-005	8
		C112,	. . Capacitor, Fixed ceramic,	16757455-002	2
		C212	0.01UF, 50VDC		
6-12	23		. . Washer, Flat, NO. 6	16755674-008	12

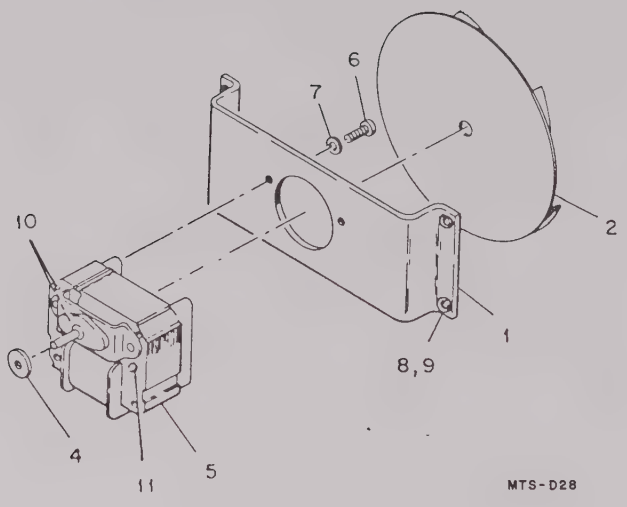


Figure 6-13. Vacuum Fan Assy

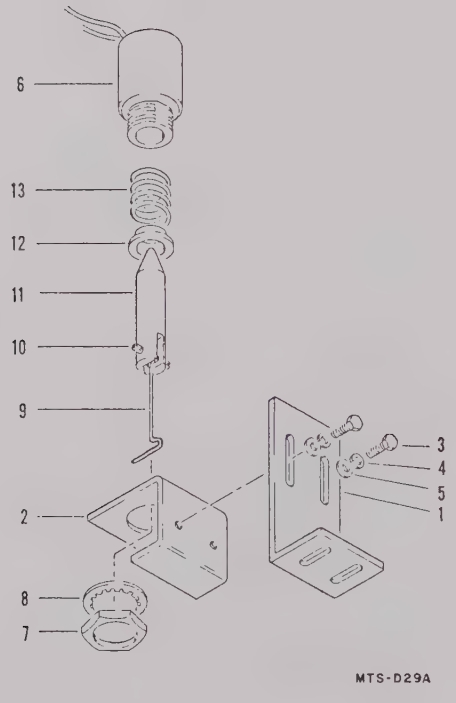


Figure 6-14. Solenoid Assembly

FIG. NO.	ITEM NO.	DESCRIPTION	PART NO.	QTY.
6-13		BRACKET ASSEMBLY, Motor Vacuum	16774185-001	REF
	1	. Bracket, Mounting, vacuum	16774583-001	1
	2	. Fan, Vacuum	16800153-003	1
	3	. Nut, Hex, 6-32	NX2006	2
	4	. Washer, Felt	16776926-001	1
	5 B1	. Motor, 115 Vac, 60 Hz	16774978-001	1
	6	. Screw, P.H., 6-32 by 1-5/8 In.	1HS632-26D	2
	7	. Washer, Lock, Int tooth, No. 6	16750431-005	2
	8	. Grommet, Rubber	ND40180-21	3
	9	. Bushing, Brass	21596	3
6-13	10	. Washer, flat	ND41045-2	A/R
6-14		SOLENOID ASSEMBLY	16775293-003	REF
	1	. Bracket, Angle	16775340-001	1
	2	. Bracket, Subassembly	16775367-001	1
		(ATTACHING PARTS)		
	3	. Screw, Hex Hd 6-32 by 3/8 IN	16750351-406	2
	4	. Washer, Lock No. 6	16750431-005	2
	5	. Washer, Flat No. 6	16755674-008	2
K1	6	. Solenoid	16775319-001	1
		(ATTACHING PARTS)		
	7	. Nut (Part of K1)	No Number	1
	8	. Washer, Star (Part of K1)	No Number	1
	9	. Wire, Linkage	16805095-003	1
		(ATTACHING PARTS)		
	10	. Pin, Roll 1/8 x 5/8 Lg.	16750292-060	1
	11	. Plunger, Solenoid (Part of K1)	No Number	1
	12	. Washer, Shouldered	16775257-001	1
6-14	13	. Spring, Helical, Compression	16760766-003	1

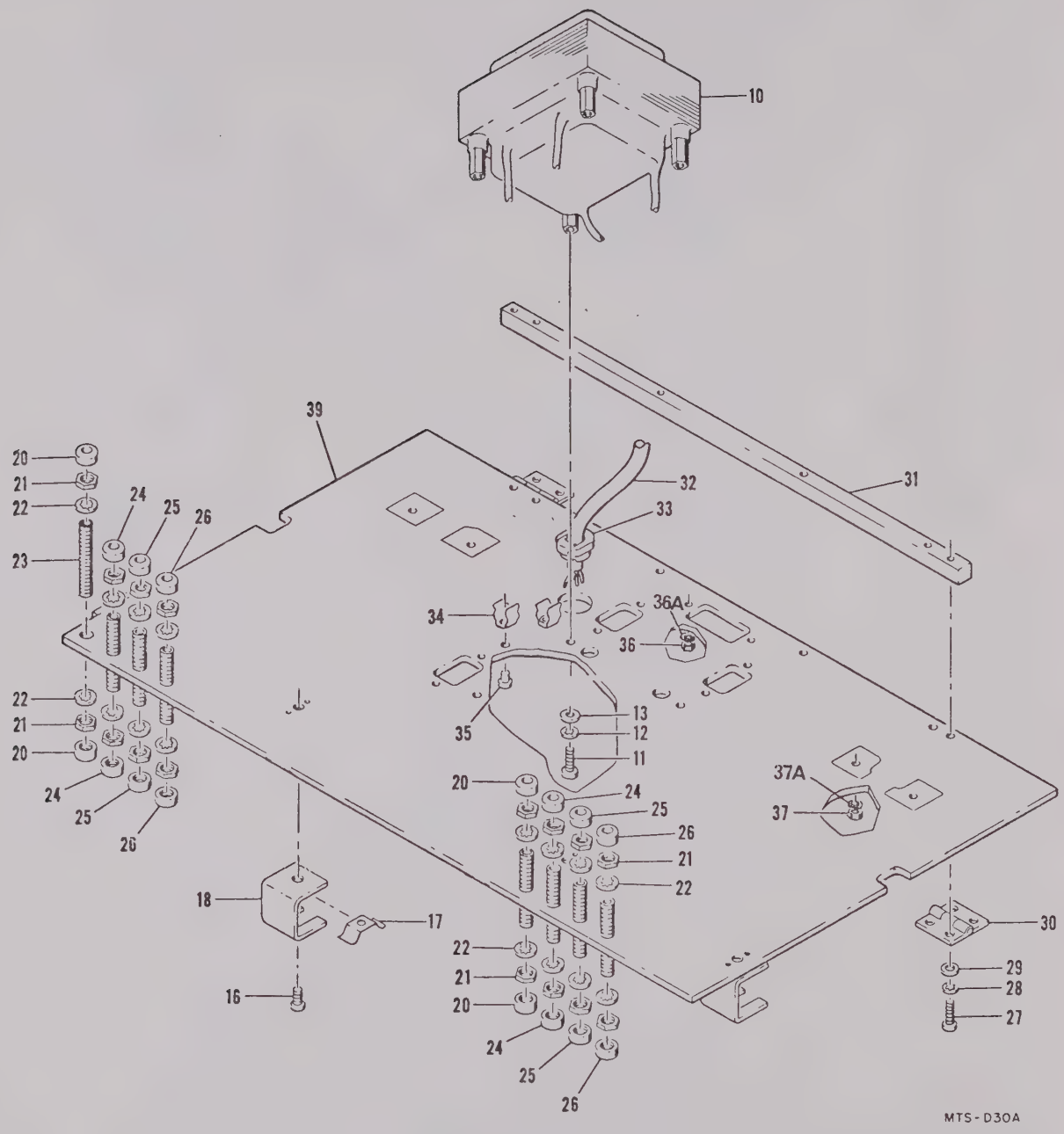


Figure 6-15. Circuit Card Assembly Mother Board (Mechanical)

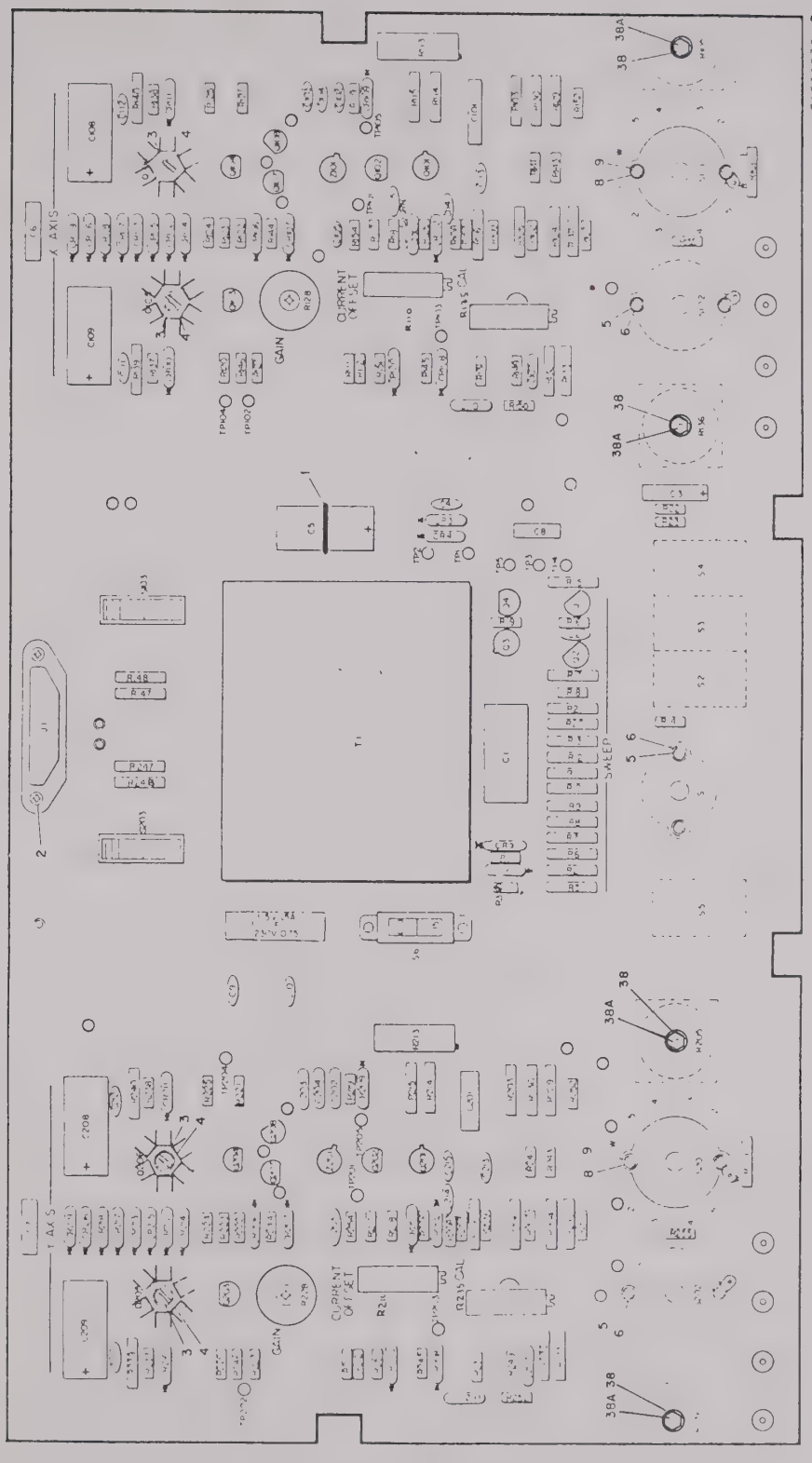


Figure 6-15. Circuit Card Assembly Mother Board (Electrical)

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15		CIRCUIT CARD ASSEMBLY Mother board	16771695-001	REF	A
		CIRCUIT CARD ASSEMBLY, Mother board	16771695-002	REF	B
		CIRCUIT CARD ASSEMBLY Mother board	16771695-003	REF	C
		CIRCUIT CARD ASSEMBLY Mother board	16771695-004	REF	D
	C1	. CAPACITOR, Fixed, plastic dielectric, 10UF, ±20%, 200 VDC	16800058-001	1	B,D
	C2	. CAPACITOR, Fixed, ceramic dielectric, 0.01UF, ±20% 50 VDC	16757455-002	1	B,D
	C3	. CAPACITOR, Fixed, electrolytic, 50UF, +100/ -10%, 15 VDC	16756939-313	1	
	C4	. CAPACITOR, Fixed, ceramic dielectric, 0.01UF, ±20%, 50 VDC	16757455-002	1	
	C5	. CAPACITOR, Fixed, electrolytic, aluminum oxide, 1000UF, +50/-10%, 50 VDC	CEL-153	1	
		(ATTACHING PARTS)			
	1	. STRAP, Rubber, electronic tie-down, 0.115 IN. DIA by 3.0 IN. LG	16755973-007	1	
	C6,C7	. CAPACITOR, Fixed, plastic dielectric, 0.047UF, ±10%, 600 VDC	16770744-175	2	
	C8	. CAPACITOR, Fixed, plastic dielectric, 0.15UF, ±5% 200 VDC	16763563-082	1	B,D
	C9,C10	. CAPACITOR, Fixed, ceramic dielectric, 0.001UF, ±10%, 1000 VDC	16750019-011	2	
	C101	. CAPACITOR, Fixed, metal polycarbonate, 1UF ±10% 1000 VDC	38127143-008	1	
	C102, C103, C104	. CAPACITOR, Fixed, ceramic dielectric, 0.01UF, ±20%, 50 VDC	16757455-002	3	
	C105	. CAPACITOR, Fixed, ceramic dielectric, 10PF, ±10%, 1000 VDC	16750036-013	1	
	C107	. CAPACITOR, Fixed, plastic dielectric, 0.022UF, ±5%, 50 VDC	16763563-222	1	
	C108, C109	. CAPACITOR, Fixed, electrolytic, 250UF, +50 -10%, 25 VDC	16758518-264	2	
	C110	. CAPACITOR, Fixed, plastic dielectric, 0.047UF, ±5%, 200 VDC	16763563-076	1	
	C111, C112	. CAPACITOR, Fixed, ceramic dielectric, 0.01UF, ±20%, 50 VDC	16757455-002	2	
	C113	. CAPACITOR, Fixed, ceramic dielectric, 0.001UF, ±10% 1000 VDC.	16750019-011	1	
6-15	C114	. CAPACITOR, Fixed, ceramic dielectric, 470UUF, ±10%, 1000 VDC	16750036-026	1	

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	C115	. CAPACITOR, Fixed, ceramic dielectric, 0.001UF, ±10%, 1000 VDC.	16750019-011	1	
	C201	. CAPACITOR, Fixed, metal, polycarbonate, 1UF, ±10%, 100 VDC	38127143-008	1	
	C202, C203, C204	. CAPACITOR, Fixed, ceramic dielectric, 0.01UF, ±20%, 50 VDC	16757455-002	3	
	C205	. CAPACITOR, Fixed, ceramic dielectric, 10PF, ±10% 1000 VDC	16750036-013	1	
	C207	. CAPACITOR, Fixed, plastic dielectric, 0.015UF, ±5%, 200 VDC	16763563-070	1	
	C208, C209	. CAPACITOR, Fixed, electrolytic, 250UF, +50/ -10%, 25 VDC	16758518-264	2	
	C210	. CAPACITOR, Fixed, plastic dielectric, 0.047UF, ±5%, 200 VDC	16763563-076	1	
	C211, C212	. CAPACITOR, Fixed, ceramic dielectric, 0.01UF, ±20%, 50 VDC	16757455-002	2	
	C213	. CAPACITOR, Fixed, ceramic dielectric, 0.001UF, ±10%, 1000 VDC	16750019-011	1	
	C214	. CAPACITOR, Fixed, ceramic dielectric, 470UUF, ±10%, 1000 VDC	16750036-026	1	
	C215	. CAPACITOR, Fixed, ceramic dielectric, 0.001UF, ±10%, 1000 VDC	16750019-011	1	
	CR1	. SEMICONDUCTOR DEVICE, Diode	16756688-060	1	B,D
	CR2	. SEMICONDUCTOR DEVICE, Diode	16756688-062	1	
	CR3, CR4	. SEMICONDUCTOR DEVICE, Diode	16756961-002	2	
	CR101, CR102	. SEMICONDUCTOR DEVICE, Diode	16756865-003	2	
	CR106, CR107	. SEMICONDUCTOR DEVICE, Diode	16756961-002	2	
	CR108, CR109	. SEMICONDUCTOR DEVICE, Diode, zener	16757931-202	2	
	CR110, CR111	. DIODE, Voltage regulator	16769141-001	2	
	CR112, thru CR119	. SEMICONDUCTOR DEVICE, Diode	16756961-002	8	
	CR120	. SEMICONDUCTOR DEVICE, Diode	16756688-062	1	
	CR201, CR202	. SEMICONDUCTOR DEVICE, Diode	16756865-003	2	
	CR206, CR207	. SEMICONDUCTOR DEVICE, Diode	16756961-002	2	
	CR208, CR209	. SEMICONDUCTOR DEVICE, . Diode, zener	16757931-202	2	
	CR210, CR211	. DIODE, Voltage regulator	16769141-001	2	
	CR212 thru CR219	. SEMICONDUCTOR DEVICE, Diode	16756961-002	8	
6-15	CR220	. SEMICONDUCTOR DEVICE, Diode	16756688-062	1	

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	F1	. FUSE, Cartridge, 0.75 AMP, 250V*	16750231-029	1	
		. FUSE, Cartridge, 1.50 AMP, 250V*	16750231-031	1	
	J1	. CONNECTOR, Receptacle, 24 pin	16750110-014	1	
		(ATTACHING PARTS)			
	2	. SCREW, Machine, pan HD, phillips DR, CS CAD plated, NO. 2-56UNC2A by 0.375 IN. LG	16765278-205	2	
		- - - * - - -			
	Q1,Q2	. TRANSISTOR	16765841-003	2	B,D
	Q3	. TRANSISTOR	16769145-001	1	B,D
	Q4	. TRANSISTOR	16762172-001	1	B,D
	Q101	. TRANSISTOR, Dual	16773669-001	1	
	Q102	. TRANSISTOR	16769136-001	1	
	Q103	. TRANSISTOR	16757925-003	1	
	Q104	. TRANSISTOR	16760945-002	1	
	Q105	. TRANSISTOR	16766748-002	1	
		(ATTACHING PARTS)			
	3	. SCREW, Binding Head, No. 4-40 by ½ IN. LG.	ND40103-20	1	
	4	. DISSIPATOR, Heat	DIS695-1B	1	
		. TRANSIPAD	16800187-001	1	
	Q106	. TRANSISTOR	16766748-005	1	
		(ATTACHING PARTS)			
	3	. SCREW, Binding Head, No. 4-40 by ½ IN. LG.	ND40103-20		
	4	. DISSIPATOR, Heat	DIS695-1B		
		. TRANSIPAD	16800187-001	1	
	Q107	. TRANSISTOR	16762173-001	1	
	Q108	. TRANSISTOR	16765841-003	1	
	Q201	. TRANSISTOR, Dual	16773669-001	1	
	Q202	. TRANSISTOR	16769136-001	1	
	Q203	. TRANSISTOR	16757925-003	1	
	Q204	. TRANSISTOR	16760945-002	1	
	Q205	. TRANSISTOR	16766748-002	1	
		(ATTACHING PARTS)			
		. SCREW, Binding Head, No. 4-40 by ½ IN. LG.	ND40103-20	1	
		. DISSIPATOR, Heat	DIS695-1B	1	
		. TRANSIPAD	16800187-001	1	
	Q206	. TRANSISTOR	16766748-005	1	
		(ATTACHING PARTS)			
		. SCREW, Binding Head, No. 4-40 by ½ IN. LG.	ND40103-20	1	
		. DISSIPATOR, Heat	DIS695-1B	1	
		. TRANSIPAD	16800187-001	1	
	Q207	. TRANSISTOR	16762173-001	1	
	Q208	. TRANSISTOR	16765841-003	1	
	R1	. RESISTOR, Fixed, carbon composition, 1.5K ohms, ±5%, 1/4W	RCC-10-152	1	B,D
	R2	. RESISTOR, Fixed, metal film, 274 ohms, ±1%, 1/2W-1W	16757166-143	1	B,D
6-15	R3	. RESISTOR, Variable, linear, 2000 ohms, ±10%, 1.0W	16774578-108	1	B,D

* NOTE: Use the 0.75 AMP fuse for 230 V operation and the 1.50 AMP fuse for 115 V operation.

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	R4	. Deleted			
	R5	. RESISTOR, Fixed, metal film, 2.05K ohms, ±1%, 1/2W - 1W	16757166-231	1	B,D
	R6	. RESISTOR, Fixed, metal film, 49.9K ohms, ±0.5%, 1W	16800218-368	1	B,D
	R7	. RESISTOR, Fixed, metal film, 49.9K ohms, ±0.5%, 1W	16800218-368	1	B
		. RESISTOR, Fixed, metal film, 75K ohms, ±0.5%, 1W	16800218-385	1	D
	R8	. RESISTOR, Fixed, metal film, 100K ohms, ±0.5%, 1W	16800218-401	1	B
		. RESISTOR, Fixed, metal film, 124K ohms, ±0.5%, 1W	16800218-410	1	D
	R9	. RESISTOR, Fixed, metal film, 301K ohms, ±0.5%, 1W	16800218-447	1	B
		. RESISTOR, Fixed, metal film, 249K ohms, ±0.5%, 1W	16800218-439	1	D
	R10	. RESISTOR, Fixed, metal film, 499K ohms, ±0.5%, 1W	16800218-468	1	B
		. RESISTOR, Fixed, metal film, 750K ohms, ±0.5%, 1W	16800218-485	1	D
	R11	. RESISTOR, Fixed, metal film, 1 MEG ohm, ±0.5%, 1W	16800218-501	1	B
		. RESISTOR, Fixed, metal film, 1.24 MEG ohm ±0.5%, 1W	16800218-510		D
	R12	. RESISTOR, Fixed, film, 3.01 MEG ohms, ±0.5%, 1/2W	16800685-612	1	B
		. RESISTOR, Fixed, film, 2.49 MEG ohms, ±0.5%, 1/2W	16800685-611	1	D
	R13	. RESISTOR, Fixed, film, 4.99 MEG ohms, ±0.5%, 1/2W	16800685-613	1	B
		. RESISTOR, Fixed, film, 7.5 MEG ohms, ±0.5%, 1/2W	16800685-614	1	D
	R14	. RESISTOR, Fixed, carbon composition, 100 ohms, ±5%, 1/4W	RCC-10-101	1	B,D
	R15	. RESISTOR, Fixed, metal film, 20K ohms, ±1%, 1W	16757166-330	1	B,D
	R16	. RESISTOR, Fixed, carbon composition,7.5K ohms ±5%, 1/4W	RCC-10-752	1	B,D
	R17	. RESISTOR, Fixed, metal film, 20K ohms, ±1%, 1W	16757166-330	1	B,D
	R18	. RESISTOR, Fixed, carbon composition, 68K ohms, ±5%, 1/4W	RCC-10-683	1	B,D
	R19	. RESISTOR, Fixed, carbon composition, 12K ohms, ±5%, 1/4W	RCC-10-123	1	B,D
	R20	. RESISTOR, Fixed, metal film, 1.0 MEG ohms, ±1%, 1W	16757166-501	1	B,D
	R21	. RESISTOR, Fixed, metal film, 20.0K ohms, ±1%, 1W	16757166-330	1	B
		. RESISTOR, Fixed, metal film, 2.49K ohms, ±1%, 1W	16757166-339	1	D
	R22	. RESISTOR, Fixed, carbon composition, 47 K ohms, ±5%, 1/4W	RCC-10-473	1	
6-15	R23	. RESISTOR, Fixed, carbon composition, 2.2K ohms ±5%, 1/4W	RCC-10-222	1	

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	R101	. RESISTOR, Fixed, metal film, 990K ohms, ±0.1%, 1W	16800219-627	1	
	R102	. RESISTOR, Fixed, carbon composition, 1.1 MEG ohms, ±5%, 1/4W	RCC-10-115	1	
	R103	. RESISTOR, Fixed, metal film, 100 ohms, ±0.1%, 1W	16800219-101	1	
	R104	. RESISTOR, Fixed, metal film, 10K ohms, ±0.1%, 1W	16800219-301	1	
	R105	. RESISTOR, Variable, linear, 10K ohms, ±5%, 2W	16770198-007	1	
		(ATTACHING PARTS)			
		. NUT (Supplied with potentiometer)			
		. WASHER (Supplied with potentiometer)			
		- - - * - - -			
	R106	. RESISTOR, Fixed, film, 909 ohms, ±1%, 1W	16757166-193	1	
	R107	. RESISTOR, Fixed, carbon composition, 3.9K ohms, ±5%, 1/4W	RCC-10-392	1	
	R108, R109	. RESISTOR, Fixed, carbon composition, 10 MEG ohms, ±10%, 1/4W	RCC-11-106	2	
	R110	. RESISTOR, Variable, 10K ohms, ±20%, 2W	52225-8	1	
	R111	. RESISTOR, Fixed, carbon composition, 22K ohms, ±5%, 1/4W	RCC-10-223	1	
	R112	. RESISTOR, Fixed, carbon composition, 27K ohms, ±5%, 1/4W	RCC-10-273	1	
	R113	. RESISTOR, Variable, 25K ohms, ±10%, 3/4W	16765947-012	1	
	R114, R115	. RESISTOR, Fixed, metal film, 200K ohms, ±1%, 1W	16757168-430	2	
	R116	. RESISTOR, Fixed, metal film, 1.0 MEG ohms, ±1%, 1W	16757166-501	1	
	R117, R118	. RESISTOR, Fixed, carbon composition, 1.2 MEG ohms, ±5%, 1/4W	RCC-10-125	2	
	R119	. RESISTOR, Fixed, carbon composition, 1.5K ohms, ±5%, 1/4W	RCC-10-152	1	
	R120, R121	. RESISTOR, Fixed, carbon composition, 22K ohms, ±5%, 1/4W	RCC-10-223	2	
	R122, R123	. RESISTOR, Fixed, carbon composition, 68 ohms, ±5%, 1/4W	RCC-10-680	2	
	R124	. RESISTOR, Fixed, carbon composition, 270 ohms, ±5%, 1/2W	RCC-1-271	1	
	R125	. RESISTOR, Fixed, carbon composition, 68 ohms, ±5%, 1/4W	RCC-10-680	1	
	R126	. RESISTOR, Fixed, carbon composition, 5.6 MEG ohms, ±5%, 1/4W	RCC-10-565	1	
6-15	R127	. RESISTOR, Fixed, carbon composition, 220 ohms, ±5%, 1/4W	RCC-10-221	1	

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	R128	. RESISTOR, Variable, 10K ohms, ±20%, 2W	16755881-008	1	
	R129	. RESISTOR, Fixed, metal film, 18K ohms, ±0.1%, 1W	16800219-606	1	A,B
		. RESISTOR, Fixed, metal film, 22.5K ohms, ±0.1%, 1W	16800219-626	1	C,D
	R130	. RESISTOR, Fixed, metal film, 2K ohms, ±0.1%, 1W	16800219-230	1	A,B
		. RESISTOR, Fixed, metal film, 2.5K ohms, ±0.1%, 1W	16800219-625	1	C,D
	R131	. RESISTOR, Fixed, carbon composition, 180K ohms, ±5%, 1/4W	RCC-10-184	1	
	R132, R133	. RESISTOR, Fixed, metal film, 976K ohms, ±1.0%, 1W	16757168-496	2	
	R135	. RESISTOR, Variable, 1K ohm, ±20%, 2W	52225-5	1	
	R5134	. RESISTOR, Fixed	RCC-10-*		
	R133	. RESISTOR, Variable, linear, 10K ohms, ±5%, 2W	16770158-007	1	
		(ATTACHING PARTS)			
		. NUT (Supplied with potentiometer)			
		. WASHER (Supplied with potentiometer)			
		- - - * - - -			
	R137, R138	. RESISTOR, Fixed, carbon composition, 470 ohms, ±5%, 1/4W	RCC-10-471	2	
	R139, R140	. RESISTOR, Fixed, carbon composition, 180 ohms, ±5%, 1W	RCC-4-181	2	
	R141	. RESISTOR, Fixed, carbon composition, 3.9K ohms, ±5%, 1/4W	RCC-10-392	1	
	R142	. RESISTOR, Fixed, metal film 10K ohms, ±1%, 1W	16757166-301	1	
	R143	. RESISTOR, Fixed, carbon composition, 12K ohms, ±5%, 1/4W	RCC-10-123	1	
	R144	. RESISTOR, Fixed, carbon composition, 3.3K ohms, ±5%, 1/4W	RCC-10-332	1	
	R145	. RESISTOR, Fixed, carbon composition, 2.2K ohms, ±5%, 1/4W	RCC-10-222	1	
	R146	. RESISTOR, Fixed, carbon composition, 1K ohms, ±5% 1/4W	RCC-10-102	1	
	R147	. RESISTOR, Fixed, metal film, 26.1K ohms, ±1%, 1/2W	16757162-341	1	E
	R148	. RESISTOR, Fixed, metal film, 49.9K ohms, ±1%, 1/2W	16757162-368	1	E
	R149	. RESISTOR, Fixed, carbon composition, 10 MEG ohms, ±5%, 1/4W	RCC-10-106	1	
	R150	. RESISTOR, Fixed, carbon composition, 10K ohms, ±5%, 1/4W	RCC-10-103	1	
6-15	R151	. RESISTOR, Fixed, carbon composition, 39K ohms, ±5%, 1/4W	RCC-10-393	1	

* Optional Resistor (500K-750K Typical Value Range Selected).

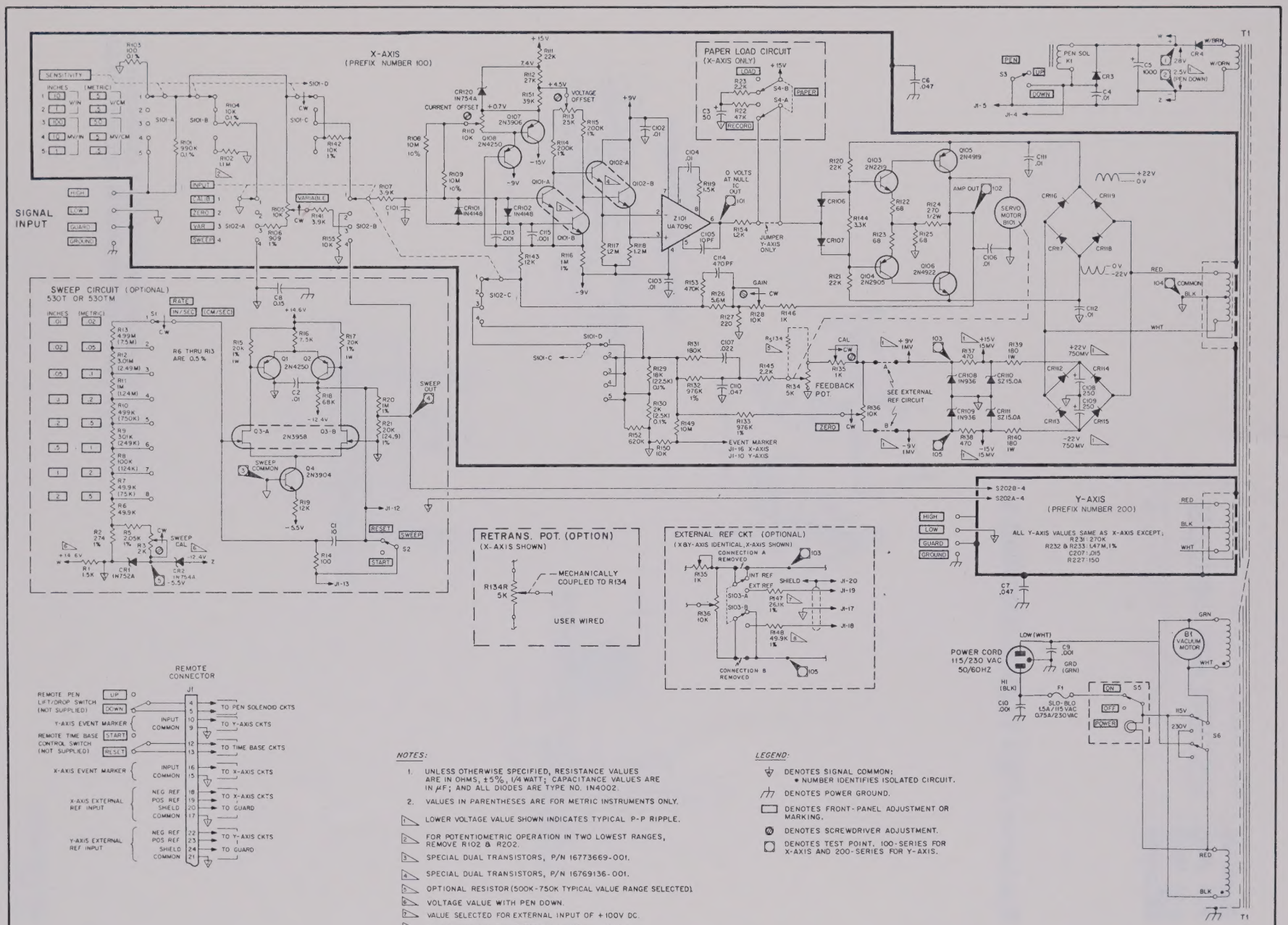
Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	R152	. RESISTOR, Fixed, carbon composition, 620K ohms, ±5%, 1/4W	RCC-10-624	1	
	R153	. RESISTOR, Fixed, carbon composition, 470K ohms, ±5%, 1/4W	RCC-10-474	1	
	R154	. RESISTOR, Fixed, carbon composition, 1.2K ohms, ±5%, 1/4W	RCC-10-122	1	
	R155	. RESISTOR, Fixed, carbon composition, 10K ohms, ±5%, 1/4W	RCC-10-103	1	
	R201	. RESISTOR, Fixed, metal film, 990K ohms, ±0.1%, 1W	16800219-627	1	
	R202	RESISTOR, Fixed, carbon composition, 1.1 MEG ohms, ±5%, 1/4W	RCC-10-115	1	
	R203	. RESISTOR, Fixed, metal film, 100 ohms, ±0.1%, 1W	16800219-101	1	
	R204	. RESISTOR, Fixed, metal film, 10K ohms, ±0.1%, 1W	16800219-301	1	
	R205	. RESISTOR, Variable, linear 10K ohms, ±5%, 2W	16770158-007	1	
		(ATTACHING PARTS)			
		. NUT (Supplied with potentiometer)			
		. WASHER (Supplied with potentiometer)			
		- - - * - - -			
	R206	. RESISTOR, Fixed, metal film, 909 ohms, ±1%, 1W	16757166-193	1	
	R207	. RESISTOR, Fixed, carbon composition, 3.9K ohms, ±5%, 1/4W	RCC-10-392	1	
	R208, R209	. RESISTOR, Fixed, carbon composition, 10 MEG ohms, ±10%, 1/4W	RCC-11-106	2	
	R210	. RESISTOR, Variable, 10K ohms ohms, ±20%, 2W	52225-8	1	
	R211	. RESISTOR, Fixed, carbon composition, 22K ohms, ±5%, 1/4W	RCC-10-223	1	
	R212	. RESISTOR, Fixed, carbon composition, 27K ohms ±5%, 1/4W	RCC-10-273	1	
	R213	. RESISTOR, Variable, 25K ohms ±10%, 3/4W	16765947-012	1	
	R214, R215	. RESISTOR, Fixed, metal film, 200K ohms, ±1%, 1W	16757168-430	2	
	R216	. RESISTOR, Fixed, metal film 1.0 MEG ohms, ±1%, 1W	16757166-501	1	
	R217, R218	. RESISTOR, Fixed, carbon composition, 1.2 MEG ohms, ±5%, 1/4W	RCC-10-125	2	
	R219	. RESISTOR, Fixed, carbon composition, 1.5K ohms, ±5%, 1/4W	RCC-10-152	1	
6-15	R220, R221	. RESISTOR, Fixed, carbon composition, 22K ohms, ±5%, 1/4W	RCC-10-223	2	

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	R222, R223	. RESISTOR, Fixed, carbon composition, 68 ohms, ±5%, 1/4W	RCC-10-680	2	
	R224	. RESISTOR, Fixed, carbon composition, 270 ohms, ±5%, 1/2W	RCC-1-271	1	
	R225	. RESISTOR, Fixed, carbon composition, 68 ohms, ±5%, 1/4W	RCC-10-680	1	
	R226	. RESISTOR, Fixed, carbon composition, 5.6 MEG ohms, ±5%, 1/4W	RCC-10-565	1	
	R227	. RESISTOR, Fixed, carbon composition, 150 ohms, ±5%, 1/4W	RCC-10-151	1	
	R228	. RESISTOR, Variable, 10K ohms, ±20%, 2W	16755881-008	1	
	R229	. RESISTOR, Fixed, metal film, 18K ohms, ±0.1%, 1W	16800219-606	1	A, B
		. RESISTOR, Fixed, metal film, 22.5K ohms, ±0.1%, 1W	16800219-626	1	C, D
	R230	. RESISTOR, Fixed, metal film, 2K ohms, ±0.1%, 1W	16800219-230	1	A, B
		. RESISTOR, Fixed, metal film, 2.5K ohms, ±0.1%, 1W	16800219-625	1	C, D
	R231	. RESISTOR, Fixed, carbon composition, 270K ohms, ±5%, 1/4W	RCC-10-274	1	
	R232, R233	. RESISTOR, Fixed, metal film, 1.47 MEG ohms, ±1.0%, 1W	16757168-517	2	
	R235	. RESISTOR, Variable, 1K ohm, ±20%, 2W	52225-5	1	
	R236	. RESISTOR, Variable, linear, 10K ohms, ±5%, 2W	16770158-007	1	
		(ATTACHING PARTS)			
		. NUT (Supplied with potentiometer)			
		. WASHER (Supplied with potentiometer)			
		- - - * - - -			
	R237, R238	. RESISTOR, Fixed, carbon composition, 470 ohms, ±5%, 1/4W	RCC-10-471	2	
	R239, R240	. RESISTOR, Fixed, carbon composition, 180 ohms ±5%, 1W	RCC-4-181	2	
	R241	. RESISTOR, Fixed, carbon composition, 3.9K ohms, ±5%, 1/4W	RCC-10-392	1	
	R242	. RESISTOR, Fixed, metal film, 10K ohms, ±1%, 1W	16757166-301	1	
	R243	. RESISTOR, Fixed, carbon composition, 12K ohms, ±5%, 1/4W	RCC-10-123	1	
	R244	. RESISTOR, Fixed, carbon composition, 3.3K ohms, ±5%, 1/4W	RCC-10-332	1	
	R245	. RESISTOR, Fixed, carbon composition, 2.2K ohms, ±5%, 1/4W	RCC-10-222	1	
6-15	R246	. RESISTOR, Fixed, carbon composition, 1K ohms, ±5%, 1/4W	RCC-10-102	1	

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	R247	. RESISTOR, Fixed, metal film, 26.1K ohms, ±1%, 1/2W	16757162-341	1	E
	R248	. RESISTOR, Fixed, metal film, 49.9K ohms, ±1%, 1/2W	16757162-368	1	E
	R249	. RESISTOR, Fixed, carbon composition, 10 MEG ohms, ±5%, 1/4W	RCC-10-106	1	
	R250	. RESISTOR, Fixed, carbon composition, 10K ohms, ±5%, 1/4W	RCC-10-103	1	
	R251	. RESISTOR, Fixed, carbon composition, 39K ohms, ±5%, 1/4W	RCC-10-393	1	
	R252	. RESISTOR, Fixed, carbon composition, 620K ohms, ±5%, 1/4W	RCC-10-624	1	
	R253	. RESISTOR, Fixed, carbon composition, 470K ohms, ±5%, 1/4W	RCC-10-474	1	
	R254	. RESISTOR, Fixed, carbon composition, 1.2K ohms, ±5%, 1/4W	RCC-10-122	1	
	R255	. RESISTOR, Fixed, carbon composition, 10K ohms, ±5%, 1/4W	RCC-10-103	1	
	S1	. SWITCH, Rotary, 1 section, 8 position, non-shorting contacts	16800036-001	1	B,D
		(ATTACHING PARTS)			
	5	. SCREW (Supplied with switch)			
	6	. WASHER (Supplied with switch)			
		- - - * - - -			
	S2	. SWITCH, Toggle, rocker. button, SPDT	16769158-002	1	B,D
	S3	. SWITCH, Toggle, rocker button, SPDT	16769158-002	1	
	S4	. SWITCH, Toggle, rocker button, DPDT	16769158-003	1	
	S5	. SWITCH, Toggle, rocker. button, SPST	16769158-001	1	
	S6	. SWITCH, Slide, detent, slot actuated, non-shorting.	16765838-001	1	
		(ATTACHING PARTS)			
	7	. Deleted			
		- - - * - - -			
	S101	. SWITCH, Rotary, 2 section, 5 position, shorting contacts	16800014-001	1	
		(ATTACHING PARTS)			
	8	. SCREW (Supplied with switch)			
6-15	9	. WASHER (Supplied with switch)			
		. LUG, Solder	16750161-102	1	

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	S102	. SWITCH, Rotary, 1 section, 4 position, non-shorting contacts	16800013-001	1	
		(ATTACHING PARTS)			
		. SCREW (Supplied with switch)			
		. WASHER (Supplied with switch)			
		. LUG, Solder	16750161-102	1	
	S103	. SWITCH, Slide, detent, non-shorting	16765838-002	1	E
		(ATTACHING PARTS)			
		. SCREW, Machine, pan HD, phillips DR, CS CAD plated, NO. 4-40 UNC2A by 0.312 IN. LG.	16765278-214	2	E
		- - - * - - -			
	S201	. SWITCH, Rotary, 2 section, 5 position, shorting contacts	16800014-001	1	
		(ATTACHING PARTS)			
		. SCREW (Supplied with switch)			
		. WASHER (Supplied with switch)			
		. LUG, Solder	16750161-102	1	
	S202	. SWITCH, Rotary, 1 section, 4 position, non-shorting contacts	16800013-001	1	
		(ATTACHING PARTS)			
		. SCREW (Supplied with switch)			
		. WASHER (Supplied with switch)			
		. LUG, Solder	16750161-102	1	
	S203	. SWITCH, Slide, detent, non-shorting	16765838-002	1	E
		(ATTACHING PARTS)			
		. SCREW, Machine, pan HD, phillips DR, CS CAD plated, NO. 4-40 UNC2A by 0.312 IN. LG.	16765278-214	2	E
		- - - * - - -			
	10 (T1)	. TRANSFORMER, Power	16800029-001	1	
		(ATTACHING PARTS)			
	11	. SCREW, Machine, pan HD, phillips DR, CS CAD plated, NO. 8-32 UNC2A by 0.500 IN. LG.	16765278-267	4	
	12	. WASHER, Lock, INT tooth, SPG. STL CAD plated, 0.020 IN. THK.	16750431-006	4	
	13	. WASHER, Flat, STL CAD plated, 0.174 IN. ID by 0.375 IN. OD by 0.032 IN. THK	16755674-010	4	
		- - - * - - -			
	14	. Deleted			
	Z101, Z201	. INTEGRATED CIRCUIT, Operational amplifier	16763333-001	2	
	15	. Deleted			
	16	. SCREW, Machine, pan HD, phillips DR, CS CAD plated, NO. 6-32 UNC2A by 0.375 IN. LG.	16765278-235	4	
	17	. SPRING, Potentiometer positioning	16771175-001	4	
	18	. BRACKET, Potentiometer	38421335-001	4	
6-15	19	. Deleted			

Fig.	Index No.	Description	Part Number	Qty.	Code
6-15	20	. CAP, Jack, black	16100495-101	4	
	21	. NUT, Plain, hexagon, BR NI plated, 1/4-32, 0.3125 IN. across flats, by 0.0625 IN. THK.	16750409-028	16	
	22	. WASHER, Lock, INT tooth, 0.267 IN. ID by 0.408 IN. OD by 0.040 IN. THK.	16756585-004	16	
	23	. POST, Jack	16805068-001	8	
	24	. CAP, Jack, blue	16100495-105	4	
	25	. CAP, Jack, white	16100495-103	4	
	26	. CAP, Jack, red	16100495-102	4	
	27	. SCREW, Machine, pan HD, phillips DR, CS CAD plated, NO. 4-40 UNC2A by 0.375 IN. LG.	16765278-215	6	
	28	. WASHER, Lock, INT tooth, SPG STL CAD plated, 0.150 IN. THK.	16750431-003	6	
	29	. WASHER, Flat, CS CAD plated, 0.125 IN. ID by 0.312 IN. OD by 0.032 IN. THK	16755674-006	6	
	30	. HINGE	16773603-001	2	
	31	. STIFFENER, Board.	16805067-001	1	
	32	. CORD, Power	8935-G	1	
	33	. BUSHING, Strain relief, cable	16750479-008	1	
	34	. CLIP, Fuse	16100028-001	2	
	35	. RIVET, Tubular, OV HD, BR, 0.123 IN. DIA by 0.188 IN. LG.	16760915-134	2	
	36	. NUT, Hex, plain, No. 2-56	NX2002	2	
	36A	. WASHER, Lock, No. 2	SP1902	2	
	37	. WASHER, Lock, No. 4	SP1904	4	
	37A	. NUT, Hex, plain, No. 4-40	ND40122-6	4	
	38	. WASHER, Lock, No. 6	SP1906	4	
	38A	. NUT, Hex, plain, No. 6-32	NX2006	4	
6-15	39	. BOARD, Printed wiring	16805066-001	1	



REMOTE CONNECTOR

REMOTE PEN LIFT/DROP SWITCH (NOT SUPPLIED)	UP	4	TO PEN SOLENOID CKTS
	DOWN	5	
Y-AXIS EVENT MARKER	INPUT	10	TO Y-AXIS CKTS
	COMMON	9	
REMOTE TIME BASE CONTROL SWITCH (NOT SUPPLIED)	START	12	TO TIME BASE CKTS
	RESET	13	
X-AXIS EVENT MARKER	INPUT	16	TO X-AXIS CKTS
	COMMON	15	
X-AXIS EXTERNAL REF INPUT	NEG REF	18	TO X-AXIS CKTS
	POS REF	19	
	SHIELD	20	TO GUARD
	COMMON	17	
Y-AXIS EXTERNAL REF INPUT	NEG REF	22	TO Y-AXIS CKTS
	POS REF	23	
	SHIELD	24	TO GUARD
	COMMON	21	

NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS, ±5%, 1/4 WATT; CAPACITANCE VALUES ARE IN μF; AND ALL DIODES ARE TYPE NO. 1N4002.
2. VALUES IN PARENTHESES ARE FOR METRIC INSTRUMENTS ONLY.
1. LOWER VOLTAGE VALUE SHOWN INDICATES TYPICAL P-P RIPPLE.
2. FOR POTENTIOMETRIC OPERATION IN TWO LOWEST RANGES, REMOVE R102 & R202.
3. SPECIAL DUAL TRANSISTORS, P/N 16773669-001.
4. SPECIAL DUAL TRANSISTORS, P/N 16769136-001.
5. OPTIONAL RESISTOR (500K-750K TYPICAL VALUE RANGE SELECTED).
6. VOLTAGE VALUE WITH PEN DOWN.
7. VALUE SELECTED FOR EXTERNAL INPUT OF +100V DC.
8. VALUE SELECTED FOR EXTERNAL INPUT OF -100V DC.

LEGEND:

- DENOTES SIGNAL COMMON; • NUMBER IDENTIFIES ISOLATED CIRCUIT.
- DENOTES POWER GROUND.
- DENOTES FRONT-PANEL ADJUSTMENT OR MARKING.
- DENOTES SCREWDRIVER ADJUSTMENT.
- DENOTES TEST POINT. 100-SERIES FOR X-AXIS AND 200-SERIES FOR Y-AXIS.

Figure 6-18. Model 530 Series X-Y Recorder Schematic Diagram

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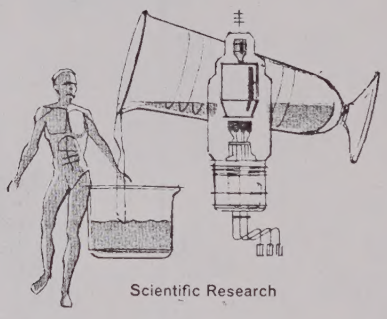
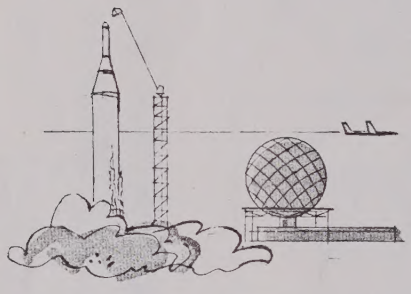
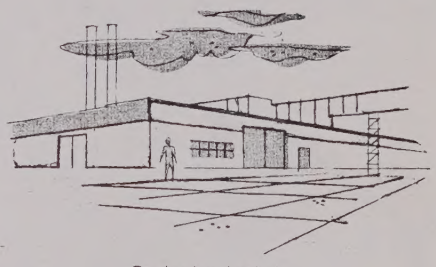


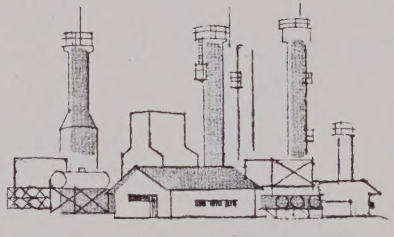
Scientific Research



Space Exploration



Production Analysis



Process Monitoring

ESTERLINE ANGUS INSTRUMENT CORPORATION
P.O. BOX 24000 · INDIANAPOLIS, INDIANA 46224

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INSTRUCTIONS FOR INSTRUMENT

Serial Number

Instruments for Data Acquisition • Analysis • Recording • Controlling

- Space Exploration
- Scientific Research
- Production Analysis
- Process Monitoring and Control

ESTERLINE ANGUS
AN ESTERLINE COMPANY

Esterline Angus Instrument Corporation
Box 24000, Indianapolis, Indiana 46224
Tel. 317-244-7611
Cable: Estango Telex: 027-419